Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
2000 Biennial Regulatory Review --	)	
Streamlining and Other Revisions of	)	
Part 25 of the Commission's Rules	)	
Governing the Licensing of, and	)	IB Docket No. 00-248
Spectrum Usage by, Satellite Network	)	
Earth Stations and Space Stations	)	
	)	

COMMENTS OF
THE SATELLITE INDUSTRY ASSOCIATION

September 6, 2005

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The Satellite Industry Association ("SIA") hereby submits its comments on the Third Further Notice of Proposed Rulemaking ("3rd FNPRM") in the above-captioned proceeding.[1]

SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, remote sensing operators, and ground equipment suppliers. SIA is the unified voice of the satellite industry on policy, regulatory, and legislative issues affecting the satellite business in the United States.[2]

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[1] Sixth Report and Order and Third Further Notice of Proposed Rulemaking, IB Docket No. 00-248, FCC 05-62 (March 15, 2005). These comments have been developed with respect to earth stations operating at fixed locations. The issues would need further consideration before being applied to other types of earth stations.

[2] SIA includes Executive Members: The Boeing Company; Globalstar LLC; Hughes Network Systems LLC; ICO Global Communications; Intelsat; Iridium Satellite LLC; Lockheed Martin Corp.; Loral Space & Communications Ltd.; Mobile Satellite Ventures; Northrop Grumman Corporation; PanAmSat Corporation and SES Americom, Inc. and Associate Members: Eutelsat Inc., Inmarsat Ltd., New Skies Satellites Inc., Stratos Global Corporation, and The DirecTV Group.

I. Introduction and Summary

In these comments, SIA addresses the following four aspects of the 3rd FNPRM: (1) EIRP density masks; (2) analog video; (3) contention protocols; and (4) protection of the NRAO radio quiet zone.

EIRP density masks. SIA supports the Commission's proposal for an EIRP density mask. Because the effects of pointing error are generally more pronounced in smaller antennas than they are in larger antennas, SIA proposes that the Commission adopt separate off-axis EIRP masks for larger antennas and smaller antennas. Under SIA's proposal, any size antenna would be eligible for routine licensing if it satisfied the applicable mask, but the specific set of off-axis EIRP envelopes to be used would vary with the size of the antenna.

As for other elements of the Commission's EIRP density mask proposal:

- The minimum angle of elevation for elliptical C-band earth station antennas should not be increased above 5° because elevation angles are low in many northern communities that rely on C-band satellite links.
- The level of protection granted to a receive antenna under §25.209(c) should continue to be based on the extent to which interference would be expected to be caused to antennas that satisfy the requirements of §25.209(a) and/or §25.209(b).
- The current procedures for resolution of complaints of harmful interference remain adequate, and there is no need for introducing additional procedures.
- In cases in which the adjacent satellite and the target satellite both are U.S.-licensed, the Commission should require that certifications under § 25.220(e)(1)(ii), to the effect that operation at higher-power has been coordinated, be signed by both the target satellite operator and the adjacent satellite operator.
- The Commission need not adopt punitive measures in order to encourage good-faith coordination.

- Requiring applicants to submit a table showing EIRP at various off-axis angles would not permit an adequate evaluation of the effects of variables such as the satellite station keeping box, earth station pointing error and variations in topocentric angles for different geographic locations. Instead, the Commission should either require a graph or mandate a format for digital submission of antenna patterns.
- SIA supports use of the proposed $10\log_{10}(N)$ approach for CDMA transmissions, but notes that in other contexts (*e.g.*, AMSS systems) in which CDMA systems assign capacity on demand and have the capability of controlling the aggregate off-axis EIRP density, limiting the off-axis EIRP density per earth station may not be appropriate.

Analog video.

SIA opposes the Commission's proposal to prohibit analog video signals. If adopted, this proposal would cost satellite customers hundreds of millions of dollars to replace equipment that would be rendered obsolete. There is no technical justification for saddling customers with expenses of this magnitude. The reception of analog video signals imposes no greater constraints on adjacent satellite operations than the reception of digital video signals, because analog signals are entitled to no more interference protection than digital signals. Nor does the transmission of analog video signals present any interference concerns because a successful system already is in place which applies total power and minimum antenna size requirements for routine licensing and adjacent satellite operators coordinate their use of analog video services. Furthermore, spectral efficiency is a non-issue. Any spectral efficiency associated with digital transmissions will be realized no matter what the Commission does in this proceeding, because it is inevitable that analog video services will be converted to digital services over time.

SIA also opposes the Commission's proposal to subject analog video signals to off-axis EIRP density limits. One cannot develop an EIRP density mask that is applicable to analog carriers modulated by all kinds of video images, because the modulating signal of an analog video carrier, unlike the modulating signal of a digital carrier, is not stationary.

Contention protocols. SIA opposes the Commission's proposal for regulating contention protocol operations. There is no evidence in the record of this proceeding, or from the experience of the satellite and network operators who have been using contention protocols for more than 20 years, that brief and infrequent contention protocol "collisions" result in any harmful interference, or any measurable interference effect at all, to satellite networks. Indeed, with one exception, all the commenters during the course of this proceeding (including SIA and its members) have consistently maintained that there is no need to treat VSAT operations using contention protocol techniques differently from any other VSAT system. The proposals of the single exception continue to be unreasonable and unsupported by adequate technical analysis or any empirical data. Under these circumstances, SIA submits that the adoption of any new regulations for contention protocol operations is unnecessary and unwarranted.

Should the Commission nevertheless decide to regulate contention protocol operations, then the FCC-proposed Table 2, which sets forth standards for VSAT network operators to exceed the aggregate off-axis EIRP envelope, should not be adopted because it does not reflect real-life VSAT operations. Moreover, adopting the Commission's proposed mask would impose substantial costs on VSAT service providers, increase the demands unnecessarily on an already limited availability of FSS satellite capacity, and likely force the abandonment of contention protocol operations. In the event the Commission decides to regulate contention protocol techniques, then SIA proposes a modified Table 2 wherein power increments are based on the realistic operation of a contention protocol channel, and specifically on the number of packets that may simultaneously be present in any given time slot. SIA also furnishes a Contention Protocol Study to demonstrate that its proposed mask easily complies with ITU-R Recommendation S.1323-2. The SIA Study also includes an appropriate standard for quantifying maximum permissible levels of interference, and demonstrates that contention protocol operations are not, in fact, causing harmful interference.

SIA also urges the Commission to adopt reasonable grandfathering provisions in connection with any contention protocol rules that may be adopted. Specifically, the Commission should not require VSAT operators that request a license modification to come into immediate compliance with the new rules for all VSATs previously authorized under that license, nor should the Commission eliminate a VSAT network's grandfathered status upon renewal of its license. Instead, in the event the Commission decides to regulate contention protocol operations, it should adopt a straightforward grandfathering period, such as fifteen years, that would apply to all VSAT licensees equally.

NRAO radio quiet zone. SIA opposes the proposal by the National Radio Astronomy Observatory ("NRAO") to require VSAT operators to coordinate with NRAO before installing and operating remote earth stations in the National Radio Quiet

Zone ("NRQZ"). The proposal is unnecessary because the Commission already provides a forum for NRAO to protect its interests. Under the current rules, VSAT operators are required to notify NRAO when filing applications for systems that could include new remote terminals within the NRQZ. NRAO may oppose the applications if it has interference concerns. Adopting NRAO's proposal would be contrary to the public interest, because it would delay the introduction of new services and would, by giving NRAO a right of refusal over the deployment of earth stations within the NRQZ, substitute NRAO for the Commission as the *de facto* arbiter of NRQZ interference disputes.

II. Off-axis EIRP Masks

A. Adoption of Off-Axis EIRP Masks

SIA supports the off-axis EIRP mask approach proposed by the Commission in the 3rd FNPRM and in general agrees with the Commission's rationale for adopting this approach.[3] Licensing earth stations based on an off-axis EIRP mask gives satellite operators greater flexibility in deploying new services while at the same time providing protection to traffic carried on adjacent satellites.

In the 3rd FNPRM, the Commission requested comment on various issues associated with implementing an off-axis EIRP mask. SIA addresses these issues in the remainder of this section, suggesting certain refinements to the Commission's proposal.

The principal refinement concerns measures to prevent or limit the impact of earth station antenna pointing error. Because the effects of mispointing are generally

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[3] See ¶ 74 of 3rd FNPRM.

more pronounced in smaller antennas than they are in larger antennas, SIA proposes that the Commission adopt separate off-axis EIRP masks for larger antennas and smaller antennas. Under SIA's proposal, "the Commission [would] review FSS earth station applications in the C-band and Ku-band solely on the basis of an off-axis EIRP envelope,"[4] *i.e.*, an antenna of any size would be eligible for routine licensing if it satisfied the envelope, but the specific off-axis EIRP envelope to be used would vary depending on the size of the antenna. SIA sets forth its complete technical justification for this proposal at the end of this section.

B. Minimum Earth Station Elevation Angle

The Commission also invites comments on whether the minimum elevation angle above the horizon should be increased, for C-band earth stations, above the 5 degree-minimum currently in the rules.[5] SIA is of the view that the minimum elevation angle should not be increased above 5 degrees. Many northern communities rely on C-band satellite links as their only communications option, and link elevation angles necessarily will be low. Moreover, the distribution of C-band terrestrial links in these areas on the whole tends to be relatively low.

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4 See ¶ 75 of 3rd FNPRM.

5 See ¶ 82 of 3rd FNPRM.

C. Protection of Receive Earth Stations from Adjacent Satellite Transmissions

In its petition for reconsideration of the 5th R&O, SIA stated its position concerning the extent to which non-compliant receive earth stations may claim protection against interference from adjacent satellites.[6] SIA understands that, even if off-axis EIRP masks are implemented and used to determine whether a transmitting earth station antenna is entitled to routine licensing, as proposed in the 3rd FNPRM, the receive antenna performance standards in §25.209 would still remain in effect. Thus, the protection of an antenna that does not comply with these standards would continue to be defined by §25.209(c). As discussed in the SIA petition for reconsideration of the 5th R&O, unambiguous characterization of the protection of non-compliant antennas would require modifications to §25.220(c)(3) and §25.220(d)(1) of the rules.[7]

With respect to non-compliant antennas, the Commission asks whether raising the antenna gain reference pattern to start at 1.5° from the main lobe should affect the level of protection afforded to receive antennas.[8] SIA believes that the level of protection afforded to a receive antenna under §25.209(c) should continue to be based on the extent to which interference would be caused to antennas that satisfy the requirements of §25.209(a) and/or §25.209(b). Therefore, setting the starting angle in §25.209(a) at 1.5° automatically will establish the level of protection to which earth stations are entitled under §25.209(c). For this purpose, SIA supports setting the starting angle at 1.5°.

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6 See Section 3 of the SIA Petition for Reconsideration of the 5th R&O.

7 See Section 3 of the SIA Petition for Reconsideration of the 5th R&O.

8 See ¶ 91 of 3rd FNPRM.

D. Resolution of Complaints of Harmful Interference

SIA agrees that in the event earth stations are licensed based on an off-axis EIRP envelope, the Commission can continue to rely on the current procedures for resolving complaints of harmful interference. These measures have proven to be effective and there is no need to adopt additional procedures.[9]

E. Applications for Earth Stations that Exceed the Off-Axis EIRP Envelope

With one exception, SIA believes that the procedures adopted in the 5th R&O -- consisting of certification of pre-filing coordination and post-filing coordination based on public comment and additional inter-operator discussion -- are appropriate for use in evaluating applications for earth stations that exceed specified off-axis EIRP envelopes. For the reasons stated in its petition for reconsideration of the 5th R&O, however, SIA believes that "[i]n cases in which the adjacent satellite and the target satellite both are U.S.-licensed, the certification required under § 25.220(e)(1)(ii), to the effect that operation at higher-power has been coordinated, should be signed by both the target satellite operator and the adjacent satellite operator."[10] For similar reasons, SIA believes that under an off-axis EIRP envelope regime both signatures should be required, for applications in which the applicable envelope is exceeded if the two operators are U.S.-licensed.

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9 See ¶ 92 of 3rd FNPRM.

10 *See* Petition for Reconsideration of the Satellite Industry Association, IB Docket No. 00-248 and CC Docket No. 86-496 at p. 4 (July 5, 2005).

Other than as described above, SIA is of the view that no additional or alternative procedures are required in evaluating earth station applications that exceed the applicable off-axis EIRP envelope. In particular, SIA opposes penalties or punitive actions "designed to enforce good-faith coordination."[11]

F. Information Requirements

The Commission proposes that applicants present off-axis EIRP information in the form of a table, as opposed to in the form of a graph.[12] SIA submits that a short table with off-axis EIRP density values, for instance at 2°, 4° and 6°, is inadequate to take into account the effect of variables such as the satellite orbital box, earth station pointing error and variations in topocentric angles for different geographic locations. SIA urges, therefore, that the current graph system be continued. An alternative would be to adopt a format for digital submission of antenna patterns, *e.g.*, an ASCII file with one data point per line, data points every 0.1° up to 10° from boresight (roughly the limit of the ITU coordination arc) and every 5° afterwards. In this way, the Commission could easily load the data into a spreadsheet and verify compliance with the off-axis EIRP envelope.

11 See ¶ 96 of 3rd FNPRM.

12 See ¶ 97 and 98 of 3rd FNPRM.

G. Off-Axis EIRP Envelope per Earth Station Versus Aggregate Off-Axis EIRP Envelope

SIA supports the off-axis EIRP envelope per earth station approach proposed by the Commission and reflected in the tables in Sections II and IV of Appendix C by the introduction of the term $10\log_{10}(N)$, where for CDMA transmissions "N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam."[13] SIA notes, however, that in other contexts (*e.g.*, AMSS systems), in which CDMA systems assign capacity on demand and have the capability of controlling the aggregate off-axis EIRP density, limiting the off-axis EIRP density per earth station may not be appropriate.

H. Proposed Minor Corrections to Appendix C

Throughout Appendix C, the phrase "no individual sidelobe exceeds the envelope given above by more than 3 dBW/4 kHz[14] should read "no individual sidelobe exceeds the envelope given above by more than 3 dB." Similarly, the phrase "shall not exceed the envelope by more than 6 dBW/4 kHz"[15] should read "shall not exceed the envelope by more than 6 dB." Moreover, the first entry (first row, first column) of the first table in Section II of Appendix C that currently reads "27.3 - $10\log_{10}(N)$ - $25\log_{10}\theta$" should read "26.3 - $10\log_{10}(N)$ - $25\log_{10}\theta$."

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13 See text below the first table in Sections II and IV of Appendix C to the 3rd FNPRM.

14 See text below the first table in Sections I, II, II and IV of Appendix C to the 3rd FNPRM.

15 See text below the second table in Sections I, II, II and IV of Appendix C to the 3rd FNPRM.

I. Earth Station Antenna Pointing Accuracy

In its petition for reconsideration[16] of the 6th R&O,[17] SIA expressed concern as to whether setting the starting angle at 1.5º for standard patterns to be met by earth station antennas would sufficiently take into account pointing errors that are likely to be associated with small antennas. However, because "the starting angle of 1.5º does not become effective until the resolution of the off-axis EIRP issues addressed in the 3rd FNPRM," SIA noted it would address that issue in the context of this 3rd FNPRM. SIA herein proposes a modified off-axis EIRP density approach that will account for pointing errors with greater precision.

In addressing the antenna gain pattern for earth station antennas within the GSO orbital plane, the Commission observed that

> [t]he topocentric angle is always greater than the geocentric angle. At latitudes within the United States, the topocentric angle between two degree separated satellites is usually between 2.1° and 2.2°, depending on the earth station's angle of elevation. Because Commission rules require that space stations be designed to be capable of maintaining orbital longitude within 0.05° of their assigned orbital location, adjacent satellites at closest approach would be separated by at least a 2° topocentric angle. Thus, setting the starting point of the antenna gain pattern envelope at 1.5° off-axis will limit potential interference into 2° separated satellites, and adequately account for potential pointing error of those earth station facilities.[18]

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16 SIA Petition for Reconsideration of 6th R&O

17 FCC 05-62 (March 15, 2005).

18 ¶ 22 of 3rd FNPRM (footnotes omitted).

SIA agrees that this approach adequately accounts for potential pointing error in certain cases. As shown in Figure 1, however, there are other cases in which this approach is inadequate for limiting potential interference in a 2° spacing environment.

Figure 1 presents the transmit antenna pattern of a Ku-band earth station antenna with a diameter of 0.6 m. For reference purposes the 29 – 25logθ is also included in Figure 1.

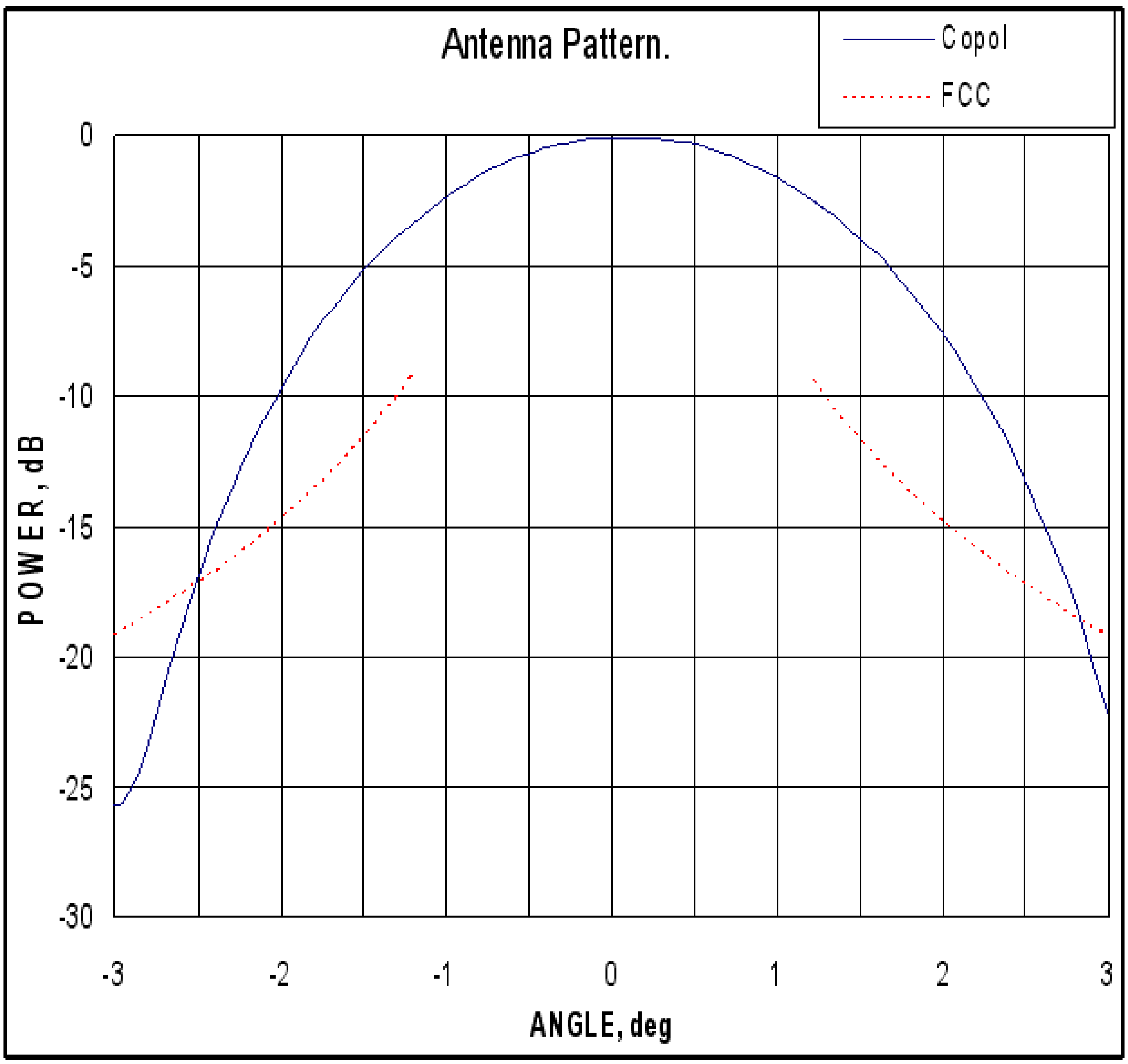

Figure1. Transmit Gain Pattern of a 0.6 m Ku-band Earth Station Antenna.

For angles in the range $1.5^{\circ} \leq \theta \leq 7^{\circ}$, the off-axis EIRP density limit proposed by the Commission for FDMA or TDMA digital signals is[19]

$$15 - 25\log\theta \text{ dB(W/4 kHz)}$$

This limit corresponds the combination of an input power of -14 dB(W/4 kHz) with a standard gain pattern of $29 - 25\log\theta$.

It can be seen from Figure 1 that the gain pattern of the 0.6 m antenna exceeds the standard pattern by about 8 dB at 1.5° and by less than 8 dB for angles greater than 1.5°. Therefore, in order to meet the $15 - 25\log\theta$ dB(W/4 kHz) mask in the range of angles under consideration, the input power has to be reduced to -22 dB(W/4 kHz), *i.e.*, an 8 dB reduction from -14 dB(W/4 kHz).

If the antenna is mispointed by 0.5°,[20] the nominal EIRP density at 1.5°, *i.e.,* $15 - 25\log(1.5) = 10.6$ dB(W/4 kHz), will be radiated towards 2°, which exceeds the limit at 2°, *i.e.,* $15 - 25\log(2) = 7.5$ dB(W/4 kHz), by 3.1 dB. This outcome stems from the fact that the antenna gain at 1.5° will, because of the 0.5° pointing error, become the antenna gain for an off-axis angle of 2°. Therefore, the power reduction should be the amount by which this gain exceeds $29 - 25\log(2)$ and not the amount by which the gain exceeds $29 - 25\log(1.5)$ as implied by the off-axis EIRP limit. As a result, the Commission's belief that "by beginning the antenna gain pattern envelope at 1.5° off-axis, we have accounted for the possibility of pointing error sufficiently that no other pointing error requirements are needed at this time"[21] is incorrect.

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19 See Appendix C, Section IV(1), of the 3rd FNPRM.

20 See ¶ 22 of the 3rd FNPRM.

21 See ¶ 28 of the 3rd FNPRM.

SIA notes that conducting off-axis EIRP density calculations at 2^{o} is fully justified. As the Commission has recognized, "the difference between geocentric and topocentric angles provides an additional safeguard against harmful interference to adjacent satellites."[22] Basing the calculations on an off-axis angle of 2.1^{o} or 2.2^{o}, moreover, would have only a minimal impact on the results described.[23]

Whenever a pointing error of 0.5^{o} occurs, the 3.1 dB deficit will exist for all such antennas (C-band or Ku-band). SIA recognizes that larger antennas are unlikely to have pointing errors of this magnitude and in many cases these errors may be small enough to be negligible. As a result, there are antennas that do not require any corrective action, but there also are antennas for which the shortcomings described above need to be corrected.

Accounting for the precise degree of mispointing for every class of antenna would involve a level of complexity that the Commission plainly should avoid. However, the Commission can improve its ability to compensate for pointing error to a substantial degree by adopting one of the approaches suggested below.

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22 See ¶ 22 of the 3rd FNPRM.

23 For a 0.5^{o} mispointing error the off-axis EIRP at 2.1^{o} and 2.2^{o} would be 0.8 dB and 1.6 dB lower than that at 2^{o}. However, the off-axis EIRP limits at 2.1^{o} and 2.2^{o} are, respectively, 0.5 dB and 1.0 dB more stringent than at 2^{o}. Therefore, the deficit of 3.1 dB observed at 2^{o} would be reduced to 2.8 dB at 2.1^{o} and to 2.5 dB at 2.2^{o}.

SIA's Proposed Approach

SIA suggests that two different sets of off-axis EIRP density limits be used. The first set of limits would be that proposed in Appendix C of the 3rd FNPRM and would be applicable to larger antennas for which pointing errors are not significant. The second set of limits would be applicable to smaller antennas for which greater pointing errors may occur.

The boundary between the classes of antennas that should comply with the first set of limits and the classes of antennas that should comply with the second set of limits is necessarily arbitrary, because there is no absolute point of demarcation between the two. Based on antenna sizes that are more likely to be subject to pointing errors as large as 0.5^o, SIA proposes that the boundaries for C-band and Ku-band antennas be set to an effective diameter of 2.4 m and 0.70 m, respectively, so that antennas with equivalent diameters equal to or smaller than these sizes would be subject to tighter EIRP density limits.[24] For example, for C-band antennas with equivalent diameters greater than 2.4m, digital emissions in the plane of the geostationary orbit would be subject to the limits in Table 1, as proposed in Appendix C, Section II(1), of the 3rd FNPRM, i.e.[25]

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24 Given that ESV antennas have a tighter pointing accuracy requirement, and that there are AMSS systems authorized to operate using active control of pointing and aggregate emissions levels, SIA recognizes that the Commission may subject ESV and AMSS antennas to different uplink off-axis E.I.R.P. masks. This is corroborated by the fact that the present FNPRM does not address ESV or AES terminals, which are dealt with under separate proceedings.

25 In the 3rd FNPRM, the entry in the first row and first column appears as $27.3 - 25\log_{10}\theta$ instead of $26.3 - 25\log_{10}\theta$ as it should be (see Section 1.8 above). Additionally, the entry in the second row appears as 5.3 instead of 5.2 as it should be.

Table 1

$26.3 - 25\log_{10}\theta$	dBW/4 kHz	For	$1.5° \le \theta \le 7°$
5.2	dBW/4 kHz	For	$7° < \theta \le 9.2°$
$29.3 - 25\log_{10}\theta$	dBW/4 kHz	For	$9.2° < \theta \le 48°$
- 12.7	dBW/4 kHz	For	$48° < \theta \le 180°$

where it has been assumed that N=1. For CDMA transmissions the $10\log_{10}(N)$ term would be included in the formulas in Table 1.

For C-band antennas with equivalent diameter of 2.4 m or less, digital emissions in the plane of the geostationary orbit would be subject to the limits in Table 2 below.

Table 2

$26.3 - 25\log_{10}(\theta + 0.5)$	dBW/4 kHz	For	$1.5° \le \theta \le 6.5°$
5.2	dBW/4 kHz	For	$6.5° < \theta \le 8.7°$
$29.3 - 25\log_{10}(\theta + 0.5)$	dBW/4 kHz	For	$8.7° < \theta \le 47.5°$
- 12.7	dBW/4 kHz	For	$47.5° < \theta \le 180°$

The envelopes in Table 2 are derived by shifting the envelopes in Table 1 to the left by 0.5^{o}. In this way, the envelope at 1.5^{o} becomes 3.1 dB more stringent and takes care of the deficit of 3.1 dB discussed above.

Similarly, for Ku-band antennas with equivalent diameter greater than 0.70 m, digital emissions in the plane of the geostationary orbit would be subject to the limits in Table 3, as proposed in Appendix C, Section IV(1), of the 3rd FNPRM, i.e.

Table 3

$15 - 25\log_{10}\theta$	dBW/4 kHz	For	$1.5° \leq \theta \leq 7°$
-6.1	dBW/4 kHz	For	$7° < \theta \leq 9.2°$
$18 - 25\log_{10}\theta$	dBW/4 kHz	For	$9.2° < \theta \leq 48°$
- 24	dBW/4 kHz	For	$48° < \theta \leq 85°$
- 14	dBW/4 kHz	For	$85° < \theta \leq 180°$

where it has been assumed that N=1. For CDMA transmissions the $10\log_{10}(N)$ term would be included in the formulas in Table 3.

For Ku-band antennas with equivalent diameter equal to or less than 0.70 m digital emissions in the plane of the geostationary orbit would be subject to the limits shown in Table 4 below.

Table 4

$15 - 25\log_{10}(\theta + 0.5)$	dBW/4 kHz	For	$1.5° \leq \theta \leq 6.5°$
-6.1	dBW/4 kHz	For	$6.5° < \theta \leq 8.7°$
$18 - 25\log_{10}(\theta + 0.5)$	dBW/4 kHz	For	$8.7° < \theta \leq 47.5°$
- 24	dBW/4 kHz	For	$47.5° < \theta \leq 84.5°$
- 14	dBW/4 kHz	For	$84.5° < \theta \leq 180°$

Off-axis EIRP limits in all other directions, *i.e.*, outside the plane of the geostationary orbit, would be those proposed in Appendix C of the 3rd FNPRM, irrespective of the size of the antenna.

The same approach would apply to antennas used for transmission of analog signals that are subject to uplink off-axis E.I.R.P. density limits.

Possible Alternative Approach

In the foregoing approach, a constant pointing error correction of 0.5° was assumed for all small antennas and no allowance was made for small antennas that are designed to have a pointing accuracy better than 0.5 degrees. An alternative approach would be identical to the proposed approach, except that it would also permit the licensee to request that a pointing accuracy tighter than 0.5 degrees be assumed in Tables 2 and 4.

Under this approach, the licensee would submit information with its application supporting the request for a smaller pointing error and this material would be placed on public notice to give interested parties an opportunity to comment. If the Commission accepted the applicant's showing, the application would then be evaluated using either Table 2 or 4, but with the 0.5 degree figure adjusted to the demonstrated value. The advantage of this approach would be to give licensees an incentive to deploy terminals that are capable of better pointing accuracy. As an example, under this approach an application for authorization of a small Ku-band antenna with a pointing accuracy of 0.3 degrees would be evaluated against the mask shown in Table 5 below.

Table 5

$15 - 25\log_{10}(\theta + 0.3)$	dBW/4 kHz	For	$1.5° \leq \theta \leq 6.7°$
-6.1	dBW/4 kHz	For	$6.7° < \theta \leq 8.9°$
$18 - 25\log_{10}(\theta + 0.3)$	dBW/4 kHz	For	$8.9° < \theta \leq 47.7°$
- 24	dBW/4 kHz	For	$47.7° < \theta \leq 84.7°$
- 14	dBW/4 kHz	For	$84.7° < \theta \leq 180°$

In sum, SIA supports the Commission's proposal for an EIRP density mask, and recommends that the Commission adopt one of SIA's two proposals for multiple masks. These proposals account for the fact that the effects of pointing error are more pronounced in smaller antennas. SIA also respectfully requests that the Commission make the additional refinements to its EIRP density mask proposals that are identified in Section I of these comments.

III. Analog Video

Following the decisions taken in the 5th R&O, analog video transmissions must comply with both an upper limit on the total power delivered to the transmit earth station antenna and a lower limit on antenna size (minimum equivalent antenna diameter[26]) in order to qualify for routine licensing. In the C-band, analog video earth stations will be routinely licensed if the input power does not exceed 26.5 dBW and the equivalent diameter is equal to or greater than 4.5 m. In the Ku-band, routine licensing for analog video requires a maximum input power of 27 dBW and a minimum equivalent diameter of 1.2 m.[27]

In the 3rd FNPRM, the Commission notes that there are no EIRP density limits for analog video earth stations and invites comments on how to address analog video "under off-axis EIRP requirements."[28] The Commission offers three options: (1) for analog video signals use the same off-axis EIRP density limits that it proposed in the 3rd

[26] The equivalent diameter is the diameter of a hypothetical circular aperture antenna with the same aperture area as the actual antenna. See changes to § 25.201 in Appendix B of the 5th R&O.

[27] See change to § 25.211(d) in Appendix B of the 5th R&O.

[28] See ¶ 84 of the 3rd FNPRM.

FNPRM for other analog signals; (2) develop a new set of off-axis EIRP density limits for analog video signals; or (3) prohibit analog video transmissions.

For reasons discussed below, the Commission should not adopt any of these options. There is no technical justification for applying EIRP density limits to analog video transmissions. Moreover, a prohibition of analog video transmissions is neither necessary nor appropriate. The satellite industry is in the best position to determine when and how analog video services should be converted to digital video services. This conversion process is well underway, and the pace of conversion will need to vary over time in response to market forces. It would be counterproductive, therefore, to dictate a rigid time frame within which conversion must be completed. Moreover, because analog video signals still are widely used, mandating a conversion to digital signals would impose significant costs on satellite users.

A. EIRP density limits are inappropriate for analog video signals

In considering whether to adopt EIRP density limits, there is a critical distinction between analog and digital video signals. The power spectral density of digital signals can be readily defined, making it a relatively simple matter to develop a uniform EIRP density standard for such signals.[29] The power spectral density of an analog carrier frequency modulated by a video signal ("TV/FM"), on the other hand, cannot be accurately defined because the modulating signal itself is not stationary. Consequently, one cannot develop an EIRP density mask that is applicable to analog carriers modulated by all kinds of video images.

[29] The same is true to a certain extent of analog signals that are modulated by other kinds of signals (*e.g.*, frequency-division-multiplex signals).

For the purpose of conducting interference calculations, an analog video signal is sometimes characterized as a carrier that is modulated by a low-frequency triangular waveform (energy dispersal). The corresponding power spectral density ("psd") is assumed to be constant within the frequency excursion of the carrier and equal to the total power divided by the peak-to-peak frequency deviation. However, this approach has two basic drawbacks.

First, using a constant psd does not provide an accurate reflection of the interference potential of an analog video signal. For instance, it is well known that when the victim receiver is a narrowband carrier, assuming a flat spectrum characterization can underestimate the effects of a slowly-swept carrier.[30]

Moreover, at least in the Ku-band, whenever a modulating video signal is present, energy dispersal may not be present. Therefore, simply relying on a flat psd corresponding to a carrier modulated by an energy dispersal signal may lead to interference events that cannot be predicted by the operator of an adjacent satellite network.

Given the above, Options 1 and 2 proposed by the Commission in the 3rd FNPRM are inappropriate for licensing earth stations that transmit analog video signals.

30 See Recommendation ITU-R S.671-3, "Necessary Protection Ratios for Narrow-Band Single Channel-per-Carrier Transmissions Interfered With By Analogue Television Carriers".

B. There is no basis for prohibiting analog video transmissions

The Commission identifies three possible bases for prohibiting analog video transmissions: a desire to minimize interference, the promotion of spectrum efficiency, and a declining use of analog video signals.[31] As shown below, however, none of these considerations supports the drastic step of eliminating analog video transmissions.

1. Interference should not be a concern

In ¶87 of the 3rd FNPRM, the Commission states that "analog video transmissions are more susceptible to harmful interference from other transmissions and more likely to cause harmful interference to other transmissions." Nothing about the interference-related characteristics of analog video signals, however, would support prohibiting the transmission and reception of such signals.

Insofar as reception is concerned, the relative susceptibility to harmful interference of analog video signals and digital video signals is irrelevant. Analog video signals impose no greater constraints on transmissions from adjacent satellite networks than digital video signals, because under the Commission's rules the reception of analog video signals is entitled to no greater protection against interference than the reception of digital signals. The same principle applies in coordination between satellite operators; no additional protection is given to the reception of analog video signals.

31 See ¶ 87 of the 3rd FNPRM.

With respect to signal transmissions, the theoretical possibility that analog video transmissions could cause harmful interference also should be of no concern. There is an established system in place to prevent such interference which has worked well for many years. Under this system, the Commission applies total power and minimum antenna size requirements for routine licensing and adjacent satellite operators coordinate their use of analog video services. These procedures ensure that satellite operators know which center frequencies and polarization analog video signals are utilizing on adjacent satellites, and this knowledge enables operators to plan their loading accordingly. There is no need to make radical changes to a system that is working well.

It is also noteworthy that, although analog video transmissions are more interfering than other transmissions in some respects, they are less interfering in other respects. For example, if the spectral characteristics of a TV/FM carrier and a MCPC (multi-channel per carrier) digital carrier, both saturating a 36 MHz transponder, are compared, the energy of the TV/FM carrier is more concentrated around the center frequency while that of the digital carrier is approximately flat throughout the transponder. As a result, the analog carrier is more interfering within the 6 or 7 MHz around the center frequency and less interfering elsewhere. As discussed above, the increased risk of interference around the center frequency is handled routinely by operators through coordination and harmonized traffic loading.

Moreover, U.S.-licensed C-band satellites must comply with Commission requirements establishing a polarization plan and specifying the center frequency for analog video transmissions.[32] These measures ensure that the range of frequencies for which interference is greater falls within the guard-band of the adjacent satellite transponders that have the same polarization. The Commission also requires that FSS space stations operating in the 4/6 GHz band be "capable of switching polarization sense upon ground command"[33] to ensure continued compliance with the polarization plan even if a C-band satellite is relocated. U.S.-licensed space stations have always incorporated this switching capability, which does not significantly affect satellite design and implementation.

These safeguards, combined with the fact that operators of adjacent satellites coordinate their transmissions and take the appropriate measures to prevent the occurrence of unacceptable interference, make the current licensing process fully satisfactory. In addition, this licensing process is simple and straightforward -- the vast majority of licenses can be processed routinely -- and for many years coordination between operators has proven to be an effective way of solving interference-related concerns.

Of the interference events that are associated with video signals, SIA believes that most are attributable to transmissions from satellite news gathering ("SNG") trucks. These SNG trucks bring up new carriers on a daily and sometimes hourly basis under conditions in which there are extreme time pressures for information delivery. As a result, there is always the possibility that human error will cause interference

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32 See § 25.211(a).
33 See § 25.210(a)(3).

events to occur. An incorrectly selected satellite, polarization, or transponder can be the cause of short but significant interference events. The root of the problem in such cases is in the SNG service itself and how it is operated rather than in the nature of the signal. For this reason, elimination of analog video transmissions would not resolve the problem.

Satellite operators have been working hard to reduce SNG related interference events and will continue to do so. To the extent that the Commission deems it advisable to explore avenues other than self-regulation, SIA respectfully suggests that the appropriate place for such considerations would be in a separate proceeding.

2. Spectral Efficiency is a Non-Issue

In ¶87 of the 3rd FNPRM, the Commission states that "a prohibition on analog video transmissions may result in more efficient spectrum use." The relative spectral efficiency of analog signals and video signals, however, is not the appropriate point of comparison. No matter what the Commission does in this proceeding, any spectral efficiency associated with digital transmissions will be realized, because it is inevitable that analog video services will be converted to digital services over time. The Commission, however, should not adopt a rule that would render hundreds of millions of dollars of analog equipment obsolete before market conditions justify a total conversion.

3. Conversion within a pre-determined time frame will impose a significant economic burden

In the 3rd FNPRM, the Commission asks whether requiring that video signals be converted in the near term from an analog format to a digital format would cause "hardship," and it requests that interested parties elaborate upon the nature of the hardship.[34] Requiring conversion to a digital format would impose an extreme hardship, because analog video transmissions are extensively used and the cost of converting such a large number of signals would be staggering.

Although a transition from analog to digital video signals is occurring and is being accelerated by the deployment of HDTV signals, the use of analog video signals remains significant. For example, multiple satellite neighborhoods have been deployed over the United States. These satellite neighborhoods provide access to programming for cable systems throughout the country and enable hundreds of broadcasters and programmers to reach the growing U.S. television market. A substantial percentage of the video transmissions that are distributed via the satellite neighborhoods are analog transmissions. Also, many SNG transmissions both in C-band and Ku-band are analog transmissions.

The cost of converting analog video signals to a digital format would be enormous. SIA understands that various program networks will be commenting on this issue as it affects them. In the aggregate, conversion would cost hundreds of millions of dollars. Absent compelling reasons, and SIA submits that none exist, the Commission should not impose a hardship of this magnitude on the industry and

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34 See ¶ 88 of the 3rd FNPRM.

should not prohibit a class of satellite transmissions on which such heavy reliance is placed.

In summary, the first two options offered by the FCC (off-axis EIRP density limits) are inappropriate because of the non-stationary nature of the modulating signal and, as a consequence, the difficulty of defining the power spectral density of an analog video signal.

The third option (prohibition of analog video transmissions) is undesirable and unnecessary. It is undesirable because it would have a severe economic impact on current users. Contrary to suggestions in the 3rd FNPRM, the use of analog video signals, although decreasing over time, is still significant enough that any prohibition would impose a severe economic burden on users. Prohibiting analog video transmissions is unnecessary because only a need to cure severe drawbacks in the current environment could justify such a drastic measure.

The current licensing procedures and coordination efforts between satellite operators have successfully addressed potential interference problems for many years. Interference events that may be associated with analog video signals (*e.g.*, interference from SNG trucks) are a function of SNG service characteristics and are not a function of the analog or digital nature of the transmission.

The fact that "off-axis EIRP requirements" are being introduced and analog video transmissions do not fit well within this framework provides no justification for a drastic change in the rules, especially where no interference problems currently exist and where the digital transition is already occurring and accelerating by virtue of an ever-increasing number of HDTV channels.

IV. Contention Protocols Do Not Cause Harmful Interference And Do Not Warrant The Proposed Regulation.

A. Interference Concerns Expressed In The Past Are Questionable At Best and Should Not Be Credited.

The Commission proposes in the 3rd FNPRM that certain Ku-band VSAT systems using contention protocols would be eligible for routine processing. Over the course of this proceeding, the Commission has refined its proposal based on the input of numerous parties who have experience using contention protocol technology, including SIA and its members.

In the 3rd FNPRM, the Commission found that the record does not yet provide a basis for determining whether or to what extent to limit the power levels resulting from contention protocol "collisions,"[35] and it therefore seeks further input with respect to its contention protocol proposal. Contention protocol techniques are used when a VSAT terminal initially "logs on" to its network and then later signals its need for a channel to communicate. The network hub then immediately assigns communications bandwidth to the terminal, at which point the latter ceases the use of contention protocol techniques for the remainder of the transmission. The use of contention protocol techniques demonstrably increases VSAT system efficiency and maximizes the efficiency and usage of the licensed spectrum. When two earth stations using

[35] 3rd FNPRM, ¶ 115.

contention protocol techniques transmit simultaneously, an occasional collision lasting a small fraction of a second can result that briefly exceeds the Commission's power limits. There is no concrete evidence in the record in this proceeding, or from the experience of the satellite and network operators over many years, that such brief and infrequent contention protocol collisions actually result in harmful interference or that they merit any FCC rule changes.

Indeed, all but one of the many commenters in this proceeding (including SIA and its various members) have maintained that there is no need to treat VSAT systems using contention protocols differently from any other VSAT system -- and nothing in the experience of SIA members over the past two years since the last substantial comments addressing this issue would lead to a change in this conclusion. VSAT operators have been using contention protocol channels for over twenty years and have extensive experience and first-hand familiarity with contention protocol operations. There is simply no evidence that the use of contention protocol techniques results in harmful interference -- to adjacent satellite operations or any one else.

In this proceeding, the Commission has had the difficult task of balancing the facts presented by the overwhelming majority of commenters, including SIA and its members, against the interests of a single party, Aloha Networks, Inc.[36] Aloha Networks has offered comments and proposals without adequate technical support,

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[36] One other party, Qualcomm, previously had joined Aloha Networks in demanding unreasonably overprotective interference standards for contention protocol operations, but Qualcomm withdrew its support of Aloha Networks and its arguments well over a year ago. *See* Letter from Dean R. Brenner, Senior Director for Government Affairs, Qualcomm, to Marlene Dortch, Secretary, FCC, IB Docket No. 00-248 (Mar. 31, 2004).

perhaps in order to render its proprietary access technology more competitive.[37] Whatever Aloha Networks' intentions might have been, the fact remains that there is no evidence on record indicating that contention protocols cause harmful interference.[38]

SIA now asks the Commission to cease giving credence to these unsupported claims. As demonstrated below, there is simply no evidence that contention protocol channels are causing or will cause harmful interference. The Commission has no basis to impose any power restrictions specific to VSAT systems using contention protocol techniques. As shown by the SIA analysis set forth herein, adopting the FCC's proposed mask for contention protocol channels improves nothing in the interference environment over the authorized level of interference caused by static VSAT channels not using contention protocols. For this reason, SIA strongly urges the Commission not to adopt any such rule. Adopting the Commission's proposed mask would impose substantial costs on VSAT service providers, unnecessarily increase demands on an already limited availability of FSS satellite capacity, and grant unwarranted credence to the unsupported concerns of a lone commenter.

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[37] *See*, *e.g.*, Spacenet Further Reply (Apr. 8, 2003) at 5.

[38] See also *Aloha Closes Doors*, SATELLITE FINANCE, Issue 79, April 2005. On March 24, 2005, Aloha Networks filed for bankruptcy under Chapter 7 of the U.S. Bankruptcy Code.

B. Any Balancing Must Account For The Fact That Contention Protocol Channels Are Not Causing Harmful Interference.

In its 3rd FNPRM, the Commission has refined its contention protocol proposal and requests parties opposing it to offer a counter-proposal with an explanation as to why the counter-proposal "strikes a better balance" between efficient VSAT operations and interference prevention.[39] SIA strongly believes that separate regulation of contention protocols is unnecessary, and submits that the unfounded assertions of a single party, Aloha Networks, have slanted the considerations thus far. The problem, of course, is not with striking a proper balance between efficient VSAT operations and interference prevention, but that the balancing to date has been unreasonably skewed by unsupported claims of potential harmful interference. SIA believes that, if established, any FCC regulation of contention protocols must account for the fact that current contention protocol operations are not causing harmful interference and are in fact more protective of victim channels than static operation not using contention protocols. Indeed, as the attached SIA Contention Protocol Study demonstrates, in many cases the use of contention protocol channels actually leads to an improvement in the link availability of the victim over the static case.[40]

The Commission should consider and weigh the following factors in its contention protocol analysis:

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39 3rd FNPRM, ¶¶ 120-121.

40 See Contention Protocol Study, Attachment 1 at 18. As explained in the study, this aspect is due to the fact that, in the case of contention protocol operations, no packets are transmitted for about half the time.

First, as a general matter, the Commission must place any regulatory proposals addressing contention protocols through a formal, transparent, and rigorous methodology such as the one set forth in the attached study.[41] SIA believes that the absence of a grounded analytical methodology may have led to certain misunderstandings in this proceeding. Although "balancing" is a laudable objective, it is not clear what factors the Commission should be balancing in the absence of such a methodology. Merely averaging or analyzing competing proposals superficially will prove inadequate for the purposes of determining the existence or impact of potential harmful interference. It is incumbent upon the Commission to employ a more rigorous analytical approach.

Second, attempts to effectively balance and accommodate the concerns of the single proponent have caused this proceeding to stray from delineating an objective definition for *harmful interference*. SIA submits that an appropriate reference for this measure would be to Recommendation ITU-R S.1323-2, which provides that an increase of up to 10% in unavailability due to time-varying interference would have negligible effect on the performance of link budgets.[42]

Third, the Commission's "Table 2" in ¶ 119 of the 3rd FNPRM is not based upon real-life VSAT operations. Rather, "Table 2" is predicated, arbitrarily, on steps of percentages of time that reduce monotonically by a factor of 10, matched with arbitrary

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41 *See* Attachment 1.

42 "[F]or a GSO/FSS network the inter-network interference caused by the earth and space station emissions of all other satellite networks operating in the same frequency band and that can potentially cause interference of time-varying nature, should…be responsible for at most 10% of the time allowance for the BER (or C/N value) corresponding to the shortest percentage of time (lowest C/N value)." Recommends 3 and 3.1 of ITU-R Recommendation S.1323-2.

2 dB power increments, with the Commission finding that this approach "seems to strike a reasonable balance."[43] Should the Commission decide to pursue regulation of contention protocol techniques, SIA believes that the power increments should be based upon the meaningful operation of a contention protocol channel and, specifically, the number of packets that may simultaneously be present in any given time slot. As such, SIA proposes that the Commission employ instead a "Table 2" structure similar to the table set forth below. Thus, in the "SIA Proposed Table 2," the left column would specify the number of packets in a time slot, and the middle column would list the power level increase associated with the indicated number of simultaneous packets. These two columns are based upon basic physics and fundamental contention protocol operations, and should not be controversial or subject to disagreement. Therefore, if the Commission decides to adopt a mask for regulating contention protocols, SIA strongly urges the Commission to employ *in toto* the two columns proposed by SIA.

Fourth, the discussion should focus on the right-hand column in SIA's Proposed Table 2 -- *i.e.*, the percentage of time for which the aggregate EIRP level can be exceeded. Such percentages for any and all Slotted ALOHA systems are derived using the following equation:

$$p_k = G^k \cdot \frac{e^{-G}}{k!}$$

where $\boldsymbol{p_k}$ is the probability of having $\boldsymbol{k}$ packets simultaneously transmitted in a slot and $\boldsymbol{G}$ is the traffic loading (*i.e.*, the number of packets transmitted divided by the number of

43 Third Further Notice, ¶ 120.

available time slots). Accordingly, the mask should be determined by an appropriate selection of ***G***, a factor that operators of contention protocol channels can control.

SIA believes that the Commission should assume for the purpose of developing any masks that a contention protocol channel is operating at 70% loading (***G*** = 0.70). As the attached SIA Contention Protocol Study shows, 70% loading is reasonably optimal for performance purposes.[44] Although peak throughput on a Slotted ALOHA channel obviously occurs at 100% loading, the associated time delay renders performance undesirable. Accounting for time delay and other operational issues, optimal performance occurs at about 70% loading.

For these reasons, SIA proposes Table 2 below as more appropriate, considering real-life VSAT operations. As noted, the percentage of time for which the aggregate EIRP level can be exceeded is calculated based on the formula described above and assumes a 70% traffic loading:[45]

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44 *See* Attachment 1 at Fig. 1.

45 A graph comparing the Commission's proposed mask with the one herein is shown in Attachment 1 at Fig. 2.

SIA PROPOSED "TABLE 2"

Number of Packets in Slot	Maximum Increase in Aggregate EIRP above FCC Allowed level[46]	Maximum Percentage of Time for which the Aggregate EIRP Level can be exceeded
0	(No power transmitted)	50.3414696209 %
1	0	15.5804983555 %
2	3.0	3.4141584126 %
3	4.77	0.5753457592 %
4	6.0	0.0785535449 %
5	7.0	0.0090026349 %
6	7.78	0.0008883621 %
7	8.5	0.0000769348 %
8	9.0	0.0000059349 %
9	9.54	0.0000004127 %
10	10	0.0000000261 %

Consistent with the request in the 3rd FNPRM,[47] SIA is attaching a study that demonstrates that this mask easily complies with *recommends* 3.1 of Recommendation ITU-R S.1323-2 and that contention protocol operations are not causing harmful interference.[48] The study analyzes the effect of contention protocol operations on an adjacent VSAT in-route carrier, which was selected as a victim because of its small bandwidth and limited power, thus making it vulnerable to adjacent satellite interference. The study demonstrates that, under the examples analyzed, the Commission's current proposal would overprotect systems by keeping the percentage

[46] The baseline for this power increase is – 14 dBW/4 kHz.
[47] 3rd FNPRM, ¶¶ 121-122.
[48] *See* Attachment 1.

increase in unavailability to less than 0.5%, far below the 10% threshold.[49] However, the Commission's proposed mask fails to reflect that contention protocol channels have a period of time over which no power is transmitted, and the proposed mask therefore is overprotective.[50] When this factor is considered, the FCC mask is shown to over-protect the victim by 17% as compared to the static case where no contention protocol techniques are used. The SIA mask, however, would result in an increase in unavailability no greater than 3%, which still is well below the 10% threshold recommended above and embodied in Recommendation ITU-R S.1323-2. In sum, SIA believes the proposed FCC mask would result in protection for the victim that is greater than that for static links, whereas SIA's proposed mask embodies a more reasonable balance between efficient VSAT operation and interference prevention.

The SIA Study results are consistent with the fact that sensitive in-route carriers routinely allocated to adjacent satellite transponders co-frequency with those used for contention protocol traffic do not experience interference. As noted above, SIA's proposed mask assumes 70% loading, a point beyond which VSAT performance becomes undesirable. In other words, assuming maximum reasonable loading and current power restrictions, harmful interference is not predicted, which is not a surprising outcome given the lack of evidence of actual interference from contention protocol operations.

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49 "Unavailability" refers to the time for which the link operates below a BER threshold. *See* Attachment 1, Section 2.4, paragraphs (1) and (2) & n.77.

50 *See* Attachment 1 at Section 2.7.

If the Commission wishes to balance the interests for and against regulation of contention protocols, it must weigh the demonstrable lack of real contention protocol interference (and the lack of any reports of contention protocol interference) against a case for restrictive power limits and their resulting costs. Tellingly, those proposing power limits did so without providing any methodology for assessing the impact of collisions on adjacent satellites and without suggesting any acceptable operational criteria. Equally significant is a lack of interference complaints concerning contention protocol channels from satellite and network operators, many of whom are the precise parties that ostensibly would benefit from the Commission's proposal. Yet everyday SIA members carry traffic adjacent to contention protocol systems that experience no harmful interference from contention protocol channels. Accordingly, there is no reasonable basis for concluding that VSATs using contention protocols and individually complying with existing power limits would cause harmful interference -- a standard which the Commission has found sufficient in the past to justify not imposing new regulations.[51]

On the other side of the equation is the efficiency of VSAT network operations which, as the Commission has recognized, increases significantly with the use of contention protocols.[52] SIA members currently operate and facilitate hundreds of thousands of VSAT terminals that rely on contention protocols and the efficiency they afford. To restrict routine processing to earth stations satisfying the Commission's

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51 *See*, *e.g.*, Letter from Julius P. Knapp, Deputy Chief, OET, to David Cavossa, Executive Director, SIA, DA 04-4062 (Dec. 30, 2004).

52 *Further Notice*, ¶ 85; 3rd FNPRM, ¶ 103.

contention protocol proposal (or, worse yet, to prohibit earth station power in excess thereof) would have tremendous economic costs that far outweigh any concerns of potential for harmful interference which, as pointed out in the SIA Contention Protocol Study, does not occur in practice. Typical traffic loadings in contention channels currently exceed the maximum power levels that would be permitted under the Commission's proposal, as the mask comparison in Figure 2 of the SIA Contention Protocol Study makes plain.[53]

If the Commission's mask proposal is adopted, satellite and earth station operations will have to redesign the entire method of assigning capacity to individual terminals and modify the hundreds of thousands of terminals currently deployed. As Aloha Networks almost certainly knew, power restrictions at the level it proposed would render current contention protocol operations unusable. Similarly, the Commission's proposal in the 3rd FNPRM likely would force the abandonment of contention protocol operations. This is no exaggeration. Currently, contention protocol operations are desirable because these VSAT systems can map multiple regular traffic channels to each contention protocol channel. The reduction in operating power required under the 3rd FNPRM's proposal would slash that ratio significantly. There is insufficient satellite spectrum capacity to account for the traffic reallocation that would result, and capacity quickly would be exhausted -- a factor obviously highlighting the spectral efficiency of contention protocol channels.

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[53] Attachment 1.

As such, the cost of adopting the 3rd FNPRM's proposal would be enormous. VSAT operators would have to develop and redesign entirely new access schemes. Assuming no VSAT retrofitting would be required (although this assumption is unreasonable), engineering costs alone for a company to develop a new access scheme would be on the order of $50-75 million. In addition, individual VSAT terminal equipment would need to be re-fitted at a cost of potentially several hundreds of dollars per terminal.

SIA reiterates that the need to regulate contention protocol techniques is not supported by the record. However, if the Commission decides to pursue the regulation of contention protocol techniques, SIA believes that the SIA proposed mask strikes a better balance between efficient VSAT operation and interference protection. Consistent with the experiences of SIA members, the SIA mask represents today's operational reality and places a more realistic limit on the potential for harmful interference from contention protocol operation than the Commission's proposed mask. Conversely, the Commission's current proposal would confer no meaningful protection or other benefit, but effectively would abolish the use of contention protocol channels. For these reasons, if the Commission decides to adopt a mask, SIA urges adoption of the SIA proposal as supported by the SIA Contention Protocol Study.

C. The Commission Should Adopt Reasonable Grandfathering Provisions.

The 3rd FNPRM proposes that, for whatever contention protocol rules are adopted, the Commission should apply the same grandfathering provisions as would apply to TDMA, FDMA, and CDMA operations.[54] As explained above, however, no specific regulation of contention protocol power limits is warranted.

If specific rules nonetheless are adopted, SIA believes that the Commission should adopt reasonable grandfathering provisions. The Commission should not, for example, require VSAT operators that request a modification to come into immediate compliance with the new rules for all VSATs previously authorized under that license.[55] As a practical matter, VSAT operators typically submit two or three wide-scale modification applications per year, so attaching a compliance aspect to modification applications would eviscerate the purpose of grandfathering and eliminate any benefit derived from adopting grandfathering provisions in the first place.

The Commission also should refrain from eliminating grandfathered status to license renewal. If a license renewed yesterday obtains grandfathered status for fifteen years, there seems to be little justification for not extending the same status to licenses renewed the day after the effective date of the adopted rules. Furthermore, eliminating a VSAT network's grandfathered status as a result of a modification or renewal would distort the marketplace because dynamic and innovative VSAT operators which constantly upgrade their networks would be put under the new regulatory burdens while operators of unchanging networks would retain the benefits of their

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54 3rd FNPRM, ¶ 135.

55 3rd FNPRM, ¶ 134.

grandfathered status. Accordingly -- and only in the case where the Commission adopts regulatory limits on the use of contention protocol techniques -- the Commission should adopt a fixed grandfathering period that would apply to all VSAT licensees equally, such as fifteen years, after which all VSAT licensees must comply with the new regulation. In this manner, all VSAT operators, to the extent necessary, could plan for the potentially devastating disruptions that designing and acquiring new network access schemes and possible retrofitting of VSATs would cause. SIA believes that such a grandfathering approach would be more reasonable than other grandfathering proposals suggested in the 3rd FNPRM.

V. There Is No Evidence That The NRQZ Is In Need Of The Additional Procedural Protections That NRAO Seeks To Impose.

The proposal by the National Radio Astronomy Observatory (the "NRAO") to require VSAT operators to coordinate with NRAO before placing remote earth stations in the National Radio Quiet Zone (the "NRQZ") appears to be a solution in search of a problem.[56] The NRAO Proposal does not provide any evidence that requiring prior coordination is necessary to remedy any existing interference problems, nor does it suggest that any foreseeable future events are likely to cause new interference. Adoption of the proposal could slow deployment of commercial systems by adding a new layer of review each time an operator seeks to add a new remote terminal within the NRQZ. Because the current system, under which VSAT operators are required to

[56] 3rd FNPRM, ¶¶ 138-142. Reply Comments of the National Radio Astronomy Observatory, IB Docket No. 00-248, filed May 7, 2001 (the "NRAO Proposal").

notify the NRAO when applying for systems that could include new remote terminals within the NRQZ, is sufficient to protect radio astronomy operations there, the Commission should not adopt the NRAO Proposal.

As the Commission notes, the NRAO proposal applies only to the placement of new remote terminals within the NRQZ and would not change the process for obtaining authorization to operate new hub stations, because obtaining such authorization already requires VSAT operators to file a modification application to which NRAO may respond.[57] Nonetheless, the NRAO Proposal would have far-reaching and potentially negative impact on VSAT earth station deployment.

VSAT operators typically add tens of thousands of new VSAT terminals every month, of which many may be located in the NRQZ. Requiring individual coordination for each terminal would delay the deployment or modification of service to end users. Based on the NRAO Proposal, one cannot assess the scope of that added delay, but there is reason to believe it would be significant. NRAO has not even shown that it has sufficient staff resources to process in a timely manner the numerous coordination requests it would receive.[58] Absent such resources, adopting the NRAO proposal would generate a backlog of coordination requests that would stand as a roadblock to needed services.

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57 3rd FNPRM, ¶ 140; see also Fifth Report and Order, ¶ 127.

58 The issue of delay is particularly important because, if the Commission grants the NRAO proposal, it can be certain that radio astronomy users at other sites will ask for similar prior coordination rights, which would only increase the number of delayed applications and the number of impacted VSAT operators and customers.

The NRAO Proposal also does not explain what standards would apply to coordination requests. The Proposal itself is vague on what types of modified analysis will be necessary to detect the "potential interference" that NRAO is concerned about.[59] This is particularly significant because requiring prior coordination essentially would give the NRAO a right of refusal over the deployment of earth stations within the NRQZ, thereby *de facto* substituting the NRAO for the Commission as the arbiter of NRQZ interference disputes.

NRAO already has a full and fair opportunity to make known any interference concerns it may have. Under the current system, NRAO is given 20 days to comment on earth station applications proposing facilities inside the NRQZ, and the Commission is committed to give due consideration to NRAO's comments.[60] NRAO has not shown any deficiencies in this process.[61] NRAO's complaints are limited to a single educational institution that intended to place an earth station to access high-speed Internet services, and NRAO has not shown that placement of this earth station caused any interference to any radio astronomy operations.[62] The current process is more than adequate to accommodate NRAO's concerns.

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59 NRAO Proposal, ¶ 5.

60 47 C.F.R. § 25.203(f).

61 Indeed, there is no reason to expect that VSAT operations create any special dangers of interference to radio astronomy uses. VSAT systems are defined to operate in the 14.0 to 14.5 GHz frequency band, which is far removed from the radio astronomy bands. The NRAO has not shown why the VSAT frequency band creates special interference concerns, and, as the Commission notes, it does not require prior coordination for other users of spectrum in the NRQZ, including terrestrial wireless users. 3rd FNPRM, ¶ 142.

62 NRAO Proposal, ¶ 4.

The vagueness of NRAO's Proposal extends to the scope of its application to different satellite systems. Although both the 5th R&O and the 3rd FNPRM suggest that the NRAO Proposal is limited to VSAT systems, the regulatory language that NRAO has proposed is general and would appear on its face to apply to other FSS services and even MSS services. If that was NRAO's intent, then the NRAO Proposal is beyond the scope of this proceeding, because the NRAO Proposal was offered in response to a Commission proposal concerning VSAT systems alone. In any case, NRAO has offered no justification for requiring non-VSAT systems to coordinate with it.

Given all these deficiencies, the Commission should reject the NRAO Proposal.

CONCLUSION

For the reasons stated herein, the Commission should modify in the manner suggested in these comments its proposals for EIRP density masks, analog video, contention protocols, and protection of the NRAO radio quiet zone.

Respectfully submitted,

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ATTACHMENT 1

SIA CONTENTION PROTOCOL STUDY

SIA Contention Protocol Study: Analysis of Interference from Slotted ALOHA Carriers

1. Introduction

In its s 3rd FNPRM, the FCC proposes new limits on VSAT services that have RF channels which use contention protocols. In these channels, a number of different users have the capability of transmitting traffic onto the channel whenever they so require. Since these users have no knowledge of whether the channel is in use or not at any given time, transmissions may be simultaneously received by the satellite. When these so-called "collisions" occur, the receiver at the hub station is generally unable to decode the information sent and the information must be re-sent.

Since VSAT networks have many terminals that share the same satellite capacity, these systems commonly make use of contention channels in order to request transmission capacity from the hub. A VSAT terminal needing to send information will typically transmit a short packet on a contention protocol channel identifying itself and its need to transmit. The hub receives the request and then assigns dedicated capacity to the VSAT for the duration of the transmission. Once the transmission is complete, the dedicated capacity is returned to a common pool.

While these terminals individually conform to the FCC limits as defined in Part 25.134(a)(1), the occasional collisions of transmissions from multiple terminals does result in an aggregate effect at the satellite for short periods of time.

The aim of this study is to analyze the impact of interference from a carrier using Slotted ALOHA traffic into sensitive carriers on an adjacent satellite.

2. Interference Analysis

2.1 Study Assumptions

As mentioned above, this study considers by analytical means the impact on a sensitive carrier of adjacent satellite interference from a VSAT carrier using Slotted ALOHA contention protocol. The selection of the interfering carrier for this analysis is a VSAT in-route, carrying information from the remote to the hub, because it is on this type of link that contention protocols are required. Hubs send out a single broadcast that is received by all remotes and consequently there is no requirement for contention protocols on the out-route (hub to remote direction).

In considering sensitive carriers for evaluation, this study also uses a VSAT in-route, as these carriers have small bandwidths, are power limited and thus highly vulnerable to earth station interference. As a result, this analysis considers a self-compatibility case of VSAT inroutes when contention protocols are taken into consideration. [63]

2.2 Contention Protocol Performance Masks

Two separate masks defining the performance of contention protocol channels are considered in this analysis. The first performance mask consists of the FCC proposal as defined in the 3rd FNPRM[64] and which is reproduced in Table 1(a) below.

This table, as proposed in the 3rd FNPRM, appears to be inconsistent with the accompanying text. For example, while the text in paragraph 119 of the 3rd FNPRM states that "VSAT network operators may exceed the envelope for no more than 1 percent of the time,"[65] implying that for 99% of the time no increase over the envelope is allowed, the percentage of time associated with a 0 dB allowed increase (i.e., no increase) is shown as 10% in the proposed table. Additionally, the values in the table can be interpreted in one of two different ways. Does, for example, the 2 dB figure connect to the time interval from 10% to 1% or does it connect to the interval from 1% to 0.1% of the time? Given the text quoted above, it is assumed in this study that the latter interpretation applies.

[63] A self –compatibility analysis in this context refers to an analysis of the impact of interference from VSAT inroutes into an identical co-frequency inroute located on an immediately adjacent satellite.
[64] Table 2, Sixth Report and Order and Third Further Notice of Proposed Rulemaking, IB Docket No. 00-248, 15 March 2005
[65] Sixth Report and Order and Third Further Notice of Proposed Rulemaking, IB Docket No. 00-248, 15 March 2005 at 119

Table 1(a) – FCC Mask

Percentage of Time	Increase in Aggregate EIRP Allowed[66]
10% (10^{-1})	0 dB
1% (10^{-2})	2 dB
0.1% (10^{-3})	4 dB
0.01% (10^{-4})	6 dB
0.001% (10^{-5})	8 dB
0.0001% (10^{-6})	10 dB
0.00001% (10^{-7})	12 dB
0.000001% (10^{-8})	14 dB
0.0000001% (10^{-9})	16 dB

Second, it is not clear whether the proposed FCC mask in Table 1(a) represents a probability distribution function[67] or a probability density function.[68] Again, based on the comment that "VSAT network operators may exceed the envelope for no more than 1 percent of the time,"[69] SIA interprets Table 1(a) as most likely being a probability distribution function, and as a result, it can be more clearly displayed as shown in Table 1(b) without changing its meaning in any way. However, for the purpose of this analysis, a probability density is required and is derived in Table 1(c) from Table 1(b).

[66] The baseline for this power increase is – 14 dBW/4 kHz.
[67] The probability distribution function of a random variable is a function that increases monotonically in range from 0 to 1. A more rigorous definition is available in most basic texts on statistics.
[68] The probability density function is the first derivative of the probability distribution function.
[69]Sixth Report and Order and Third Further Notice of Proposed Rulemaking, IB Docket No. 00-248, 15 March 2005 at 119

Table 1(b) – FCC Mask (Represented as a Probability Distribution Function)

Increase in Aggregate EIRP Allowed[70]	Percentage of Time for which increases in aggregate must not be exceeded
0 dB	99%
2 dB	99.9%
4 dB	99.99%
6 dB	99.999%
8 dB	99.9999%
10 dB	99.99999%
12 dB	99.999999%
14 dB	99.9999999%
16 dB	99.99999999%

Table 1(c) – FCC Mask (Represented as a Probability Density Function)

Condition	**Percentage of Time**
% of time for which the aggregate power is at or less than 0 dB	99%
% of time for which the aggregate power is at or less than 2 dB and greater than 0 dB	0.9%
% of time for which the aggregate power is at or less than 4 dB and greater than 2 dB	0.09%
% of time for which the aggregate power is at or less than 6 dB and greater than 4 dB	0.009%
% of time for which the aggregate power is at or less than 8 dB and greater than 6 dB	0.0009%
% of time for which the aggregate power is at or less than 10 dB and greater than 8 dB	0.00009%
% of time for which the aggregate power is at or less than 12 dB and greater than 10 dB	0.000009%
% of time for which the aggregate power is at or less than 14 dB and greater than 12 dB	0.0000009%
% of time for which the aggregate power is at or less than 16 dB and greater than 14 dB	0.00000009%

[70] The baseline for this power increase is – 14 dBW/4 kHz.

SIA recommends that the mask as presented in Table 2(a) be adopted in lieu of the proposed FCC mask. The suggested SIA mask consists of the performance description of a Slotted ALOHA contention channel operating at 70% loading (**G**=0.70). This probability density function mask is derived using the equation:

$$P_k = G^k \cdot \frac{e^{-G}}{k!} \tag{1}$$

where:

k: number of packets in a given slot
G: traffic loading which is the total number of packets transmitted per unit of time divided by the number of slots available in that time.
P_k: probability of k slots being sent in one time slot

Table 2(a) – Proposed SIA Mask – Probability Density Function

Number of Packets in a Given Time Slot	Maximum Increase in Aggregate EIRP Above FCC Limit for a Given Number of Simultaneous Packet Collisions[71]	Percentage of Time Associated with a Given Number of Simultaneous Packet Collisions
0	(No power transmitted)	49.65 %
1	0	34.76 %
2	3.0	12.16 %
3	4.77	2.838 %
4	6.0	0.4967 %
5	7.0	0.06955 %
6	7.78	0.008114 %
7	8.5	0.0008114 %
8	9.0	7.099E-05 %
9	9.54	5.522E-06 %
10	10	3.865E-07 %

[71] The baseline for this power increase is – 14 dBW/4 kHz.

The probability density mask displayed in Table 2(a) was converted into a probability distribution function in Table 2(b).

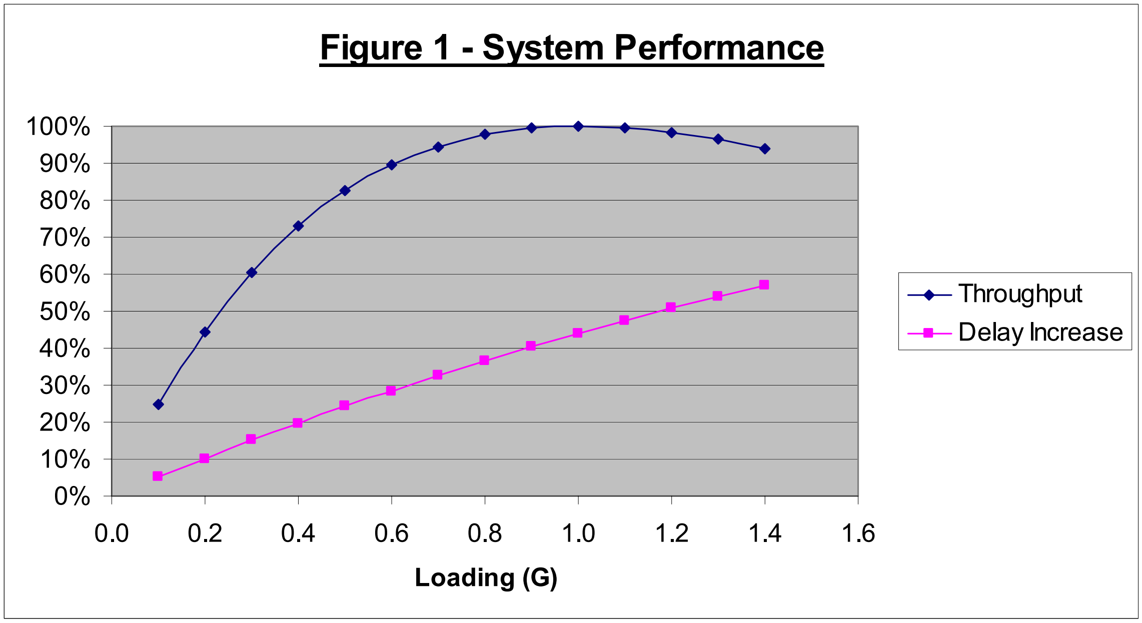
Operators of VSAT systems that make use of Slotted ALOHA channels have control over the value of **G** by various means, such as limiting the number of terminals using the channel or by controlling the amount of traffic terminals can transmit. However, other than for the value of **G**, operators using Slotted ALOHA channels are bound by the statistical characteristics defined by the curve described in equation (1).

While the peak throughput on a Slotted ALOHA channel occurs at a loading of **G**=1.00, there are practical reasons for which this value was not selected for the mask in Table 2(a) above. From Figure 1, it can be seen that at **G**=1.0, the average time delay for a response is 40% greater than for a packet not subject to collisions. Given the inherent issues associated with the delay resulting from satellite links, VSAT system designers consider increases in average packet delay to be a significant performance issue. At **G**=0.70 loading, the throughput of the channel is 95% of the maximum throughput for an average packet delay increase of 30%. Beyond 70%, the minimal increase in throughput does not compensate for the resulting increase in time delay. It becomes more effective in terms of network performance to add a new contention protocol channel rather than to suffer the increase in packet delay on the same channel.

Table 2(b) – SIA Mask – Probability Distribution Function

Number of Packets in Slot	Maximum Increase in Aggregate EIRP above FCC Allowed level[72]	Percentage of Time for which the Aggregate EIRP Level can be exceeded
0	(No power transmitted)	50.3414696209 %
1	0	15.5804983555 %
2	3.0	3.4141584126 %
3	4.77	0.5753457592 %
4	6.0	0.0785535449 %
5	7.0	0.0090026349 %
6	7.78	0.0008883621 %
7	8.5	0.0000769348 %
8	9.0	0.0000059349 %
9	9.54	0.0000004127 %
10	10	0.0000000261 %

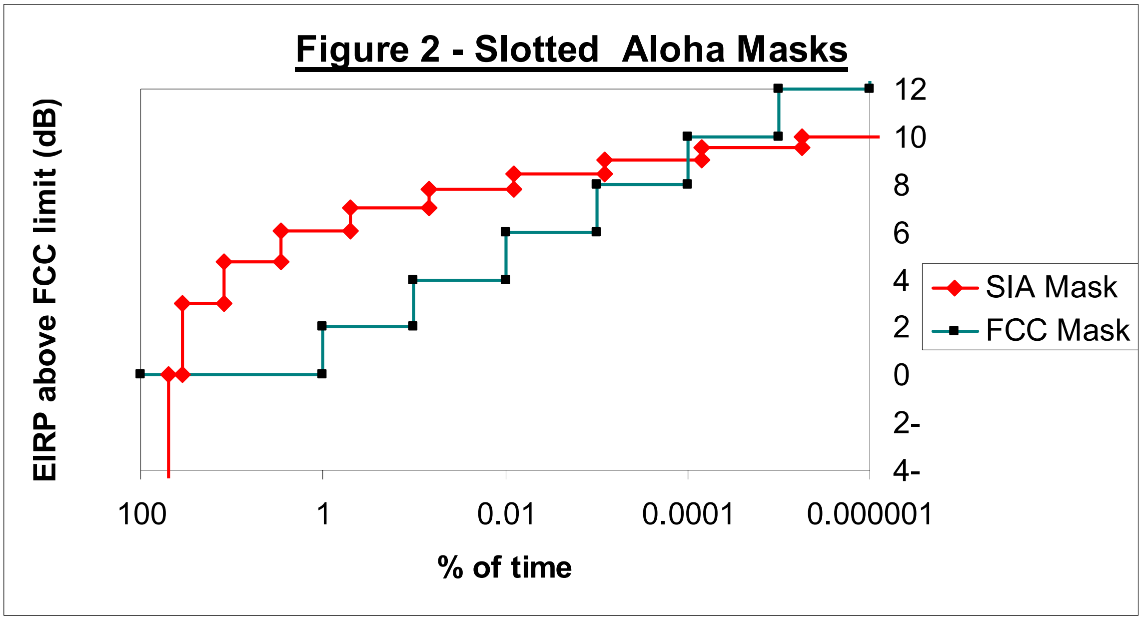
[72] The baseline for this power increase is – 14 dBW/4 kHz.



In addition, there will occur short term fluctuations in traffic that result in an increase in **G** for brief periods of time. If the network were to be operated much above **G**=0.70, the short term increases would push the channel into a state where the extra traffic would result in a reduction in throughput.

The masks in both Table 1(a) and Table 2(b) are plotted in Figure 2 below.

It bears mention that there is one critical difference between these two masks. The SIA proposed mask recommends that for approximately 50% of the time, no power is transmitted in the channel using contention protocol. There is no such limitation in the mask proposed by the FCC, where it is assumed that the maximum EIRP allowed by the FCC rules can be transmitted for 99% of the time. This difference will have an impact on the analysis, as will be seen and explained below.



2.3 Interference Model

The analysis assumes two remotes, **A** and **B**, which have the same antenna size and outdoor unit (ODU) power. These carriers operate on satellites **S1** and **S2** respectively, with there being a separation of 2 degrees between the two satellites. For the purpose of this analysis, typical VSAT characteristics consisting of an ODU power of 2W, an elliptical antenna with an effective diameter size of 74 centimeters ($\mathbf{G_{TX}}$ = 39.1 dBi), a pointing error of 0.5 dB and a carrier bandwidth of 200 kHz are assumed.

The wanted signal **C** received by **S1** from remote **A** is:

$$\mathbf{C = EIRP_A + G_1 - FSL_1} \tag{2}$$

where:

$\mathbf{EIRP_A}$:	uplink EIRP of remote **A**
$\mathbf{G_1}$:	antenna gain of satellite **S1** towards remote **A**
$\mathbf{FSL_1}$:	free space loss

The interference signal received by satellite **S1** from the remote **B** is:

$$\mathbf{I = EIRP_B + G_2 - FSL_2 - Y_D - Q} \tag{3}$$

where:

$\mathbf{EIRP_B}$:	uplink EIRP of remote **B** toward satellite **S1**
$\mathbf{G_2}$:	satellite S1 antenna gain towards remote **B**
$\mathbf{FSL_2}$:	free space loss
$\mathbf{Y_D}$:	polarization discrimination
Q	bandwidth overlap factor

The wanted EIRP is:

$$\mathbf{EIRP = G_{TX} + Power - Pointing\ loss}$$

$$= 39.1\text{ dBi} + 3\text{ dBW} - 0.50$$

$$= 41.6\text{ dBW}$$

Therefore from equation (2) above:

$$\mathbf{C = EIRP_A + G_1 - FSL_1}$$

$$= 41.6 + \mathbf{G_1 - FSL_1}$$

For the interference from a station operating on the adjacent satellite located 2 degrees away,[73] the EIRP in 4 kHz, regardless of the interfering antenna size is bounded by the FCC off-axis EIRP limit:[74]

$$\mathbf{EIRP_{4kHz}} = 15 - 25 \log(\theta) \text{ at } 2^{o}$$

$$= 15 - 25 \log_{10}(2)$$

$$= 7.5\text{ dBw/4kHz}$$

[73] While the topocentric angle is between 2.1 and 2.2 degrees for most CONUS locations, this angle does not take into account satellite station-keeping, from which an additional 0.1 degree can be subtracted to bring the value back to 2 degrees.

[74] Current FCC limit consist of the antenna mask defined in FCC Part 25.209 and the antenna flange power defined in Part 25.134(a)(1). The 3rd FNPRM on Part 25 proposes to replace both these values by a single EIRP mask.

Thus the EIRP in 200 kHz is:

$$\mathbf{EIRP} = 7.5 \text{ dBW/4kHz} + 10 \log(\mathbf{BW}/4 \text{ kHz})$$

$$= 7.5 \text{ dBW/4kHz} + 10 \log(200/4)$$

$$= 24.5 \text{ dBW}$$

Where:

BW: Bandwidth of the carrier in kHz
θ: Angle off boresight

Therefore, from (3) above:

$$\mathbf{I} = 24.5 + \mathbf{G_1} - \mathbf{FSL_2} - \mathbf{Y_D}$$

Assuming that:

$\mathbf{FSL_1 = FSL_2}$ that the distance to the satellite $\mathbf{S_1}$ from both terminals is essentially equal

$\mathbf{Y_D} = 0$, that both victim and interfering carrier are on the same polarization, which is the worst case

$\mathbf{Q} = 0$, that both victim and interfering carrier overlap completely, which is the worst case

$\mathbf{G_1 = G_2}$ without specific knowledge of the location of S1 and S2, both are assumed to have the same receive gain at the satellite.

We then have:

$$(\mathbf{C/I})_{up} = 41.6 - 24.5$$

$$= 17.1 \text{ dB}$$

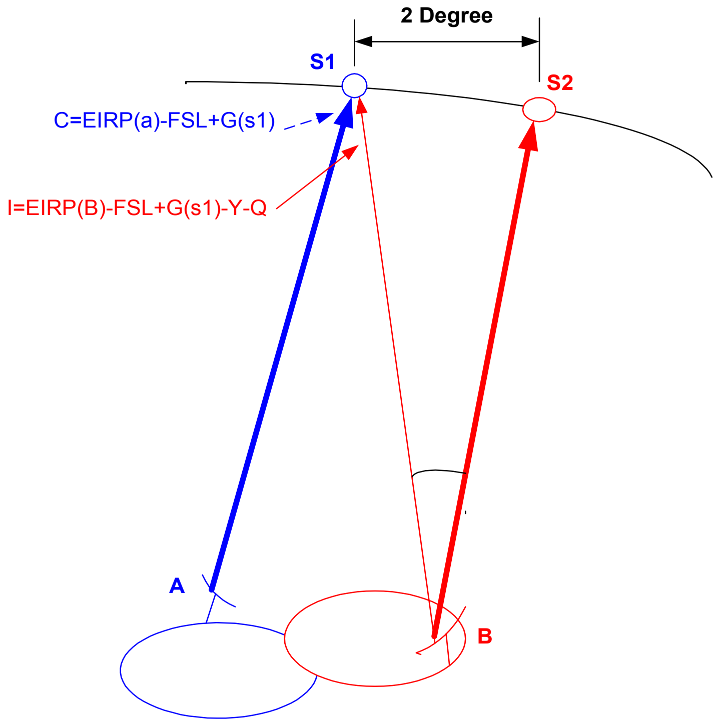


Figure 3 - Interference Model

2.4 Link Budgets

For the purpose of this analysis, link budgets were prepared in order to characterize the uplink performance of a VSAT remote. These link budgets consider the four main sources of interference which consist of thermal noise, adjacent satellite interference, cross-polarization interference, and intermodulation noise on the satellite transponder. For this analysis, values of C/I of 23 dB and 18 dB were selected for cross-polarization interference and intermodulation noise, as being typical values.

For the demodulator, two separate cases were considered consisting of:

(1) A traditional VSAT implementation using the convolutional coding and Viterbi decoding, which assuming a typical threshold performance for a R1/2 coded channel gives an Es/No of 7 dB for a bit error rate (BER) of 10^{-7}.

(2) A more modern VSAT implementation using the Turbo Coding, which assuming a typical threshold performance for a R1/2 coded channel gives an Es/No of 4 dB for a bit error rate (BER) of 10^{-7}.

The link budgets in Tables 3 and 4 address the FCC Mask, while Tables 5 and 6 relate to the SIA mask. Tables 3 and 5 both contain links which make use of conventional Viterbi decoding, while Tables 4 and 6 represent cases that make use of Turbo Coding. For the Viterbi Coding cases, it is assumed that the VSAT terminals are deployed within the satellite G/T contour bound by the +2 dB/K curve. For the Turbo Coding links, the improvement in coding performance is assumed to allow the edge of coverage (EOC) to be increased down to the satellite G/T contour defined by the -1 dB/K curve.

For each link, the calculation assumes an aggregate C/I entry for adjacent satellite interference that only takes into account the first adjacent satellite to the left and right of the victim satellite. The aggregate C/I is calculated at the bottom of the table, and the value is carried into the link budget.

For all links, ALOHA collisions from only one adjacent satellite were considered because the probability that a carrier on the same frequency and polarization being used on both adjacent satellites for contention protocol traffic was deemed to be negligible.

For those links representing the FCC case, each link represents one of the rows in Table 1(c) above. For example, the leftmost link represents the first row, which is for the 99.00% of time when the aggregate power is of -14 dBW/4kHz which results in a single satellite C/I of 17.1 dB. The power sum of the two C/I values of 17.1 dB gives an aggregate value of 14.1 dB, which is carried upwards in to the link budget. The second link budget represents a contention protocol channel having a flange power of -12 dBW/4kHz for 0.9% of the time. As a result, the single entry C/I is reduced to 15.1 dB for this interfering satellite, which when combined with the other single entry value of 17.1 dB, gives an aggregate C/I of 12.97 dB, which is carried up into the link budget. This process is repeated for the first seven rows in Table 1(c).

An identical process was followed for the SIA case. The links assume two interfering carriers, one that is time-invariant, while the other is a Slotted ALOHA channel. The first link represents the case in Table 2(a) when no packets are transmitted in a time slot. The second represents the case when one packet is transmitted in the time slot and so forth. In each case, the resulting single entry and aggregate C/I are computed for use in the link budget above.

TABLE 3 - VSAT LINK BUDGET (UPLINK) - FCC MASK - Conventional Viterbi

		Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7
EIRP	**dBW**	41.6	41.6	41.6	41.6	41.6	41.6	41.6
FSL	**dB**	207.8	207.8	207.8	207.8	207.8	207.8	207.8
G/T (EOC)	**dB/K**	2.0	2.0	2.0	2.0	2.0	2.0	2.0
BW	**kHz**	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Symbol Rate	**ksymbol/sec**	128.0	128.0	128.0	128.0	128.0	128.0	128.0
C/N (thermal)	**dB**	11.4	11.4	11.4	11.4	11.4	11.4	11.4
C/I (ASI)	**dB**	14.1	13.0	11.6	10.1	8.5	6.7	4.8
C/I (XPI)	**dB**	23.0	23.0	23.0	23.0	23.0	23.0	23.0
C/I (intermod)	**dB**	18.0	18.0	18.0	18.0	18.0	18.0	18.0
C/(N+I)	**dB**	8.8	8.4	7.9	7.2	6.3	5.1	3.7
Eb/No	**dB**	7.0	7.0	7.0	7.0	7.0	7.0	7.0
C/N (threshold)	**dB**	5.1	5.1	5.1	5.1	5.1	5.1	5.1
margin	**dB**	3.72	3.36	2.84	2.14	1.21	0.05	-1.31

ASI Calculation

Row from Table 1	1	2	3	4	5	6	7
satellite 1	17.100 dB	15.100 dB	13.100 dB	11.100 dB	9.100 dB	7.100 dB	5.100 dB
satellite 2	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB
ASI (total)	14.090 dB	12.976 dB	11.645 dB	10.127 dB	8.461 dB	6.686 dB	4.834 dB

TABLE 4 - VSAT LINK BUDGET (UPLINK) - FCC MASK - Turbo Coding

		Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7
EIRP	**dBW**	41.6	41.6	41.6	41.6	41.6	41.6	41.6
FSL	**dB**	207.8	207.8	207.8	207.8	207.8	207.8	207.8
G/T (EOC)	**dB/K**	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
BW	**kHz**	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Symbol Rate	**ksymbol/sec**	128.0	128.0	128.0	128.0	128.0	128.0	128.0
C/N (thermal)	**dB**	8.4	8.4	8.4	8.4	8.4	8.4	8.4
C/I (ASI)	**dB**	14.1	13.0	11.6	10.1	8.5	6.7	4.8
C/I (XPI)	**dB**	23.0	23.0	23.0	23.0	23.0	23.0	23.0
C/I (intermod)	**dB**	18.0	18.0	18.0	18.0	18.0	18.0	18.0
C/(N+I)	**dB**	6.9	6.7	6.3	5.8	5.1	4.2	3.1
Eb/No	**dB**	4.0	4.0	4.0	4.0	4.0	4.0	4.0
C/N (threshold)	**dB**	2.1	2.1	2.1	2.1	2.1	2.1	2.1
margin	**dB**	4.83	4.59	4.24	3.74	3.05	2.14	1.00

ASI Calculation

Row from Table 1	1	2	3	4	5	6	7
satellite 1	17.100 dB	15.100 dB	13.100 dB	11.100 dB	9.100 dB	7.100 dB	5.100 dB
satellite 2	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB
ASI (total)	14.090 dB	12.976 dB	11.645 dB	10.127 dB	8.461 dB	6.686 dB	4.834 dB

TABLE 5 - VSAT LINK BUDGET (UPLINK) - SIA MASK - Conventional Viterbi

		no packet	1 packet	2 packets	3 packets	4 packets	5 packets	6 packets
EIRP	**dBW**	41.6	41.6	41.6	41.6	41.6	41.6	41.6
FSL	**dB**	207.8	207.8	207.8	207.8	207.8	207.8	207.8
G/T (EOC)	**dB/K**	2.0	2.0	2.0	2.0	2.0	2.0	2.0
BW	**kHz**	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Symbol Rate	**ksymbol/sec**	128.0	128.0	128.0	128.0	128.0	128.0	128.0
C/N (thermal)	**dB**	11.4	11.4	11.4	11.4	11.4	11.4	11.4
C/I (ASI)	**dB**	17.1	14.1	12.3	11.1	10.1	9.3	8.6
C/I (XPI)	**dB**	23.0	23.0	23.0	23.0	23.0	23.0	23.0
C/I (intermod)	**dB**	18.0	18.0	18.0	18.0	18.0	18.0	18.0
C/(N+I)	**dB**	9.5	8.8	8.2	7.7	7.2	6.8	6.4
Eb/No	**dB**	7.0	7.0	7.0	7.0	7.0	7.0	7.0
C/N (threshold)	**dB**	5.1	5.1	5.1	5.1	5.1	5.1	5.1
margin	**dB**	4.41	3.72	3.12	2.60	2.13	1.71	1.32

ASI Calculation

packets	0	1	2	3	4	5	6
satellite 1	999.000 dB[75]	17.100 dB	14.090 dB	12.329 dB	11.079 dB	10.110 dB	9.318 dB
satellite 2	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB
ASI (total)	17.100 dB	14.090 dB	12.329 dB	11.079 dB	10.110 dB	9.318 dB	8.649 dB

[75] The single entry C/I value of 999 represents the case when there is no interfering signal, which is the case when no packets are transmitted on the contention protocol channel.

TABLE 6 - VSAT LINK BUDGET (UPLINK) - SIA MASK - Turbo Coding

		no packet	1 packet	2 packets	3 packets	4 packets	5 packets	6 packets
EIRP	**dBW**	41.6	41.6	41.6	41.6	41.6	41.6	41.6
FSL	**dB**	207.8	207.8	207.8	207.8	207.8	207.8	207.8
G/T (EOC)	**dB/K**	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
BW	**kHz**	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Symbol Rate	**ksymbol/sec**	128.0	128.0	128.0	128.0	128.0	128.0	128.0
C/N (thermal)	**dB**	8.4	8.4	8.4	8.4	8.4	8.4	8.4
C/I (ASI)	**dB**	17.1	14.1	12.3	11.1	10.1	9.3	8.6
C/I (XPI)	**dB**	23.0	23.0	23.0	23.0	23.0	23.0	23.0
C/I (intermod)	**dB**	18.0	18.0	18.0	18.0	18.0	18.0	18.0
C/(N+I)	**dB**	7.3	6.9	6.5	6.1	5.8	5.5	5.2
Eb/No	**dB**	4.0	4.0	4.0	4.0	4.0	4.0	4.0
C/N (threshold)	**dB**	2.1	2.1	2.1	2.1	2.1	2.1	2.1
margin	**dB**	5.26	4.83	4.43	4.07	3.73	3.42	3.13

ASI Calculation

packets	0	1	2	3	4	5	6
satellite 1	999.000 dB[76]	17.100 dB	14.090 dB	12.329 dB	11.079 dB	10.110 dB	9.318 dB
satellite 2	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB	17.100 dB
ASI (total)	17.100 dB	14.090 dB	12.329 dB	11.079 dB	10.110 dB	9.318 dB	8.649 dB

[76] The single entry C/I value of 999 represents the case when there is no interfering signal, which is the case when no packets are transmitted on the contention protocol channel.

2.5 Impact on Availability[77] Due to ALOHA Collision

The availability evaluation assumes the following three locations in order to assess the impact for different rain zones:

(1) Washington, DC (rain zone K)
(2) Miami (rain zone N)
(3) Los Angeles (rain zone E)

For each of the links in Tables 3 to 6, a margin was derived for each event. Given the city locations and their respective rain statistics, it is possible to find the availability, $\mathbf{P_i}$, for each event at each city using the ITU-R availability prediction methodology.[78] These availability values are listed in Tables 7 to 10 below, comparing the proposed FCC and SIA masks using Viterbi and Turbo Coding.

Table 7 - Availability Results - FCC Mask and Viterbi Decoding[79]

	Margin	Washington	Miami	LA
Table 1C, Row 1	3.72	99.8724%	99.5595%	99.9778%
Table 1C, Row 2	3.36	99.8456%	99.4761%	99.9724%
Table 1C, Row 3	2.84	99.7694%	99.2438%	99.9561%
Table 1C, Row 4	2.14	99.6017%	98.7504%	99.9184%
Table 1C, Row 5	1.21	99.0158%	97.1083%	99.7748%
Table 1C, Row 6	0.05	90.0000%	90.0000%	90.0000%
Table 1C, Row 7	-1.31	0.0000%	0.0000%	0.0000%

Table 8 - Availability Results - FCC Mask and Turbo Coding

	Margin	Washington	Miami	LA
Table 1C, Row 1	4.83	99.9278%	99.7372%	99.9886%
Table 1C, Row 2	4.59	99.9195%	99.7101%	99.9871%
Table 1C, Row 3	4.24	99.9017%	99.6527%	99.9837%
Table 1C, Row 4	3.74	99.8724%	99.5595%	99.9778%
Table 1C, Row 5	3.05	99.8064%	99.3559%	99.9641%
Table 1C, Row 6	2.14	99.6017%	98.7504%	99.9184%
Table 1C, Row 7	1.00	98.3768%	95.3906%	99.6080%

[77] The term *availability* in this document refers to the time in which the link performance exceeds a given BER threshold. The term *unavailability* refers to then time for which the link operates below this threshold.

[78] Recommendation ITU-R P.618-7.

[79] Rain models do not extend to cases with 0 rain margin. An availability value of 90% was assumed in this case where the rain margin is almost non-existent but still positive (0.05 dB). An availability of 0% was entered for cases where the link margin is negative.

Table 9 - Availability Results - SIA Mask and Viterbi Decoding				
	Margin	**Washington**	**Miami**	**LA**
No Packet	4.41	99.9117%	99.6847%	99.9856%
1 Packet	3.72	99.8724%	99.5595%	99.9778%
2 Packets	3.12	99.8153%	99.3829%	99.9660%
3 Packets	2.60	99.7320%	99.1320%	99.9479%
4 Packets	2.13	99.6017%	98.7504%	99.9184%
5 Packets	1.71	99.3926%	98.1536%	99.8686%
6 Packets	1.32	99.0158%	97.1083%	99.7748%

Table 10 - Availability Results - SIA Mask and Turbo Coding				
	Margin	**Washington**	**Miami**	**LA**
No Packet	5.26	99.9404%	99.7790%	99.9909%
1 Packet	4.83	99.9278%	99.7372%	99.9886%
2 Packets	4.43	99.9125%	99.6875%	99.9857%
3 Packets	4.07	99.8947%	99.6305%	99.9823%
4 Packets	3.73	99.8731%	99.5617%	99.9780%
5 Packets	3.42	99.8475%	99.4820%	99.9727%
6 Packets	3.13	99.8165%	99.3867%	99.9663%

Finding the net link availability for each scenario can be done using the equation:

$$A = \sum_{i=1}^{n} P_i \cdot A_i$$

Where:

A: Net link availability
A_i: Link availability during event **i**
P_i: percentage of time during which event **i** occurs (values taken from Table 1(c) for the FCC Mask or Table 2(a) for the SIA mask).
n: total number of different events

For the purposes of this study, **n** was limited to 7 terms for both the FCC and SIA masks. Considering additional terms added complexity to the calculation with negligible change in the results.

From the equation above, the net availability values in Tables 11 were derived.

Table 11 - Net Link Availability

Scenario	Viterbi Decoding Washington	Viterbi Decoding Miami	Viterbi Decoding Los Angeles	Turbo Coding Washington	Turbo Coding Miami	Turbo Coding Los Angeles
Static Case (No contention protocol)	99.8724%	99.5595%	99.9778%	99.9278%	99.7372%	99.9886%
FCC Mask	99.8720%	99.5583%	99.9777%	99.9277%	99.7369%	99.9886%
SIA Mask	99.8783%	99.5820%	99.9781%	99.9300%	99.7469%	99.9883%

Table 12 - Percentage Increase in Unavavilability

Scenario	Viterbi Decoding Washington	Viterbi Decoding Miami	Viterbi Decoding Los Angeles	Turbo Coding Washington	Turbo Coding Miami	Turbo Coding Los Angeles
FCC Mask	0.3012%	0.2605%	0.4289%	0.1459%	0.1299%	0.1823%
SIA Mask	-4.6661%	-5.1053%	-1.2510%	-3.1148%	-3.6939%	2.9208%

Using the data in Table 11, it is possible to assess the increase in unavailability using the equation:

$$\Delta U = \frac{(1 - A_{ALOHA}) - (1 - A_{STATIC})}{(1 - A_{STATIC})}$$

Where:

ΔU:	Percentage increase in unavailability
$\mathbf{U_{ALOHA}}$:	Net Unavailability with one Slotted ALOHA channel
$\mathbf{U_{STATIC}}$:	Unavailability with two static carriers

The results from the equation above are presented in Table 12. Positive values in the table represent the percentage increase in unavailability resulting from the use of contention protocols on one of the two adjacent links. Those cases where the unavailability with contention protocols is actually less than the baseline will give values in Table 12 that are negative.

2.6 <u>Performance Threshold</u>

From 1996 to 2003, the ITU-R did a significant number of studies to assess the impact of new proposed NGSO systems on existing GSO networks. This activity was in reaction to the proposed Skybridge system by Alcatel. One of the aims of these ITU-R studies was to assess the impact of time-variant interference on GSO links.

The ITU in its work established that a 10% reduction in unavailability due to time varying interference would have a negligible effect on the performance of GSO link budgets. This value has been codified in Recommendation ITU-R S.1323-2, which served as the basis for assessing the acceptability of certain NGSO networks.

"[Recommends]3 that for a GSO/FSS network the inter-network interference caused by the earth and space station emissions of all other satellite networks operating in the same frequency band and that can potentially cause interference of time-varying nature, should:
3.1 *be responsible for at most 10% of the time allowance for the BER (or C/N value) specified in the short-term performance objectives of the desired network and corresponding to the shortest percentage of time (lowest C/N value);"*[80]

While the interference being considered in this study does not originate from a NGSO system, it is time-variant and as such the value of 10% can be used in the context of this study. For our study, we have established a BER performance of 10^{-7} which gave Es/No thresholds specified in Section 2.4 above. The baseline calculation shown in the top row of Table 11 indicates the percentage of time that this performance criterion is achieved when interference is from static links. From that value of availability, it is possible to derive the link unavailability. According to Recommendation ITU-R S.1323-2, an increase in the link unavailability of 10% should not impose undue hardship on GSO networks. It bears mention that this same concept was used extensively by ITU-R JWP 4-9-11, WRC-2000 and WRC-2003 in evaluating the impact of NGSO effective power flux density (epfd)[81] on GSO links.

As a consequence, this study uses a 10% increase in unavailability as a threshold for assessing the impact of contention protocols on GSO links.

2.7 Discussion of Results

Reviewing Table 12 shows that contention protocol channels operating at the FCC and SIA masks **both** meet the 10% criterion.

For the SIA mask, the increase in unavailability as compared to the static case varied from -5% to +2.9%. The negative values indicate that the SIA mask offers a better performance than the static case in some scenarios. This is possible since the SIA mask takes into account the large percentages of time (about 50% of the time for **G**=0.70) over which no power is transmitted into the channel used for contention protocols. As a result, for about 50% of the time, the victim sees only one interfering link, which weighs significantly in the net link availability calculation.

[80] Recommendation ITU-R S.1323-2.
[81] ITU-R Radio Regulations, Article 22.5C.1 and Table 22-1A.

For the FCC mask, the increase in unavailability values ranging between 0.14% and 0.47%. Since the FCC mask does not identify a period of time over which no power is transmitted, the resulting increase in unavailability is positive. Had the FCC mask been defined with a percentage of time for which no power is transmitted, the values would have been significantly different. For a value of 50%, as was the case for the SIA mask, the FCC mask would give an unavailability increase that varies between -17% and -8%. Details of this analysis are available in Appendix 1 to this study.

3.0 Conclusion

The SIA Contention Protocol Study considered the impact of the proposed FCC and SIA masks on sensitive carriers located on an adjacent satellite. In the study, it was observed that the proposed SIA mask easily meets the 10% maximum increase in unavailability criterion established by the ITU-R for short term into GSO networks. In fact, most of the cases reviewed showed that a network compliant with the proposed SIA mask caused slightly less adjacent satellite interference than the static case operating up to authorized FCC levels. These results support SIA's assertion that the current usage of contention protocol channels has negligible impact on adjacent satellite networks and explain why no interference complaints have been received related to this type of operation.

The SIA Study also showed that the proposed FCC mask meets the 10% maximum increase in unavailability criterion. However, it was observed that the proposed FCC mask does not include a percentage of time for which no power is transmitted into the channel. Since all contention protocol channels must by their very design have a percentage of time slots which go unused, the current FCC mask significantly overestimates the interference that adjacent networks would realistically receive and as a result dramatically overprotects victim networks with its proposed mask.

In order to better quantify the interference of a typical contention protocol network complying with the proposed FCC mask, calculations were made assuming that such a system did not use 50% of the available time slots. Under this scenario, the FCC mask was found to significantly overprotect the victim. The unavailability increase in this case ranges from -17 to -8%, showing that by complying with the FCC mask, networks using contention protocols would be forced to provide significantly more protection than currently authorized systems that do not vary in time (e.g. static systems).

There is a further shortcoming with the proposed FCC mask in that its shape is inconsistent with the statistical performance curve to which contention protocol channels are bound (2 dB steps instead of the dB value of the number of packets). As a result, there is no way for a user of a Slotted ALOHA channel to take full advantage of the FCC mask. For VSAT operators to comply with the entire FCC mask would require an additional reduction in either EIRP or in the number of VSAT terminals allowed onto its network. The net result would be that the increase in unavailability would be even lower than the -17% to -8% values calculated above.

The values resulting from the SIA Study clearly show that the proposed FCC mask would result in a protection of the victim that is significantly beyond the currently authorized levels in Part 25 of the FCC's rules. The cost of this overprotection to the operators of networks using contention protocols would be a significant reduction in allowable traffic that would essentially render the contention channels unusable.

In conclusion, SIA has demonstrated that the time varying characteristics of contention protocol systems do not and cannot reasonably be expected to cause harmful interference to adjacent satellites. As a result, SIA believes that there is no need for any regulation of contention protocols. However, should the FCC pursue regulation of networks using contention protocols SIA would propose that its mask provides a better balance between protection from harmful interference and efficient VSAT network use.

Appendix 1

Were the FCC mask to be modified by identifying a percentage of time over which no power is transmitted as highlighted in Table A-1, the results obtained would have been different than in the main study.

Table A-1 – FCC Mask (Represented as a Probability Density Function)

Condition	Percentage of Time
% of time for which no power is transmitted	50%
% of time for which some power is being transmitted but at a level less than 0 dB	49%
% of time for which the aggregate power is at or less than 2 dB and greater than 0 dB	0.9%
% of time for which the aggregate power is at or less than 4 dB and greater than 2 dB	0.09%
% of time for which the aggregate power is at or less than 6 dB and greater than 4 dB	0.009%
% of time for which the aggregate power is at or less than 8 dB and greater than 6 dB	0.0009%
% of time for which the aggregate power is at or less than 10 dB and greater than 8 dB	0.00009%
% of time for which the aggregate power is at or less than 12 dB and greater than 10 dB	0.000009%
% of time for which the aggregate power is at or less than 14 dB and greater than 12 dB	0.0000009%
% of time for which the aggregate power is at or less than 16 dB and greater than 14 dB	0.00000009%

For this scenario, the link budgets used in Tables 3 and 4 remain applicable. However, an additional link is needed to represent the case where no power is transmitted. This scenario was calculated for the SIA mask and these values can be used for the analysis of the new Row 1.

This gives the results shown in Tables A-2 and A-3, which are in large part similar to Tables 7 and 8.

Table A-2 - Availability Results - FCC Mask and Viterbi Decoding[82]	Margin	Washington	Miami	LA
Table A-1, Row 1	4.41	99.9117%	99.6847%	99.9856%
Table A-1, Row 2	3.72	99.8724%	99.5595%	99.9778%
Table A-1, Row 3	3.36	99.8456%	99.4761%	99.9724%
Table A-1, Row 4	2.84	99.7694%	99.2438%	99.9561%
Table A-1, Row 5	2.14	99.6017%	98.7504%	99.9184%
Table A-1, Row 6	1.21	99.0158%	97.1083%	99.7748%
Table A-1, Row 7	0.05	90.0000%	90.0000%	90.0000%
Table A-1, Row 8	-1.31	0.0000%	0.0000%	0.0000%

Table A-3 - Availability Results - FCC Mask and Turbo Coding	Margin	Washington	Miami	LA
Table A-1, Row 1	5.26	99.9404%	99.7790%	99.9909%
Table A-1, Row 2	4.83	99.9278%	99.7372%	99.9886%
Table A-1, Row 3	4.59	99.9195%	99.7101%	99.9871%
Table A-1, Row 4	4.24	99.9017%	99.6527%	99.9837%
Table A-1, Row 5	3.74	99.8724%	99.5595%	99.9778%
Table A-1, Row 6	3.05	99.8064%	99.3559%	99.9641%
Table A-1, Row 7	2.14	99.6017%	98.7504%	99.9184%
Table A-1, Row 8	1.00	98.3768%	95.3906%	99.6080%

To determine the net availability, the equation:

$$A = \sum_{i=1}^{n} P_i \cdot A_i$$

mentioned previously can be used. For this equation::

A: Net link availability
A$_i$: Link availability during event **i**
P$_i$: percentage of time during which event **i** occurs (taken from Table A-1)
n: total number of different events

The values of net availability derived using this equation are provided in Table A-4 below. The change in unavailability with regards to the baseline scenario (two static links) is shown in Table A-5.

[82] Rain models do not extend to cases with 0 rain margin. An availability value of 90% was assumed in this case where the rain margin is non-existent but still positive (0.05 dB). An availability of 0% was entered for cases where the link margin is negative.

Table A-4 - Net Link Availability

Scenario	Viterbi Decoding Washington	Viterbi Decoding Miami	Viterbi Decoding Los Angeles	Turbo Coding Washington	Turbo Coding Miami	Turbo Coding Los Angeles
Static Case (No contention protocol)	99.8724%	99.5595%	99.9778%	99.9278%	99.7372%	99.9886%
Modified FCC Mask	99.8916%	99.6209%	99.9816%	99.9340%	99.7577%	99.9898%

Table A-5 - Percentage Increase in Unavailability

Scenario	Viterbi Decoding Washington	Viterbi Decoding Miami	Viterbi Decoding Los Angeles	Turbo Coding Washington	Turbo Coding Miami	Turbo Coding Los Angeles
Modified FCC Mask	-15.096%	-13.952%	-17.033%	-8.591%	-7.819%	-10.015%